Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.
+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.
+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.
+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

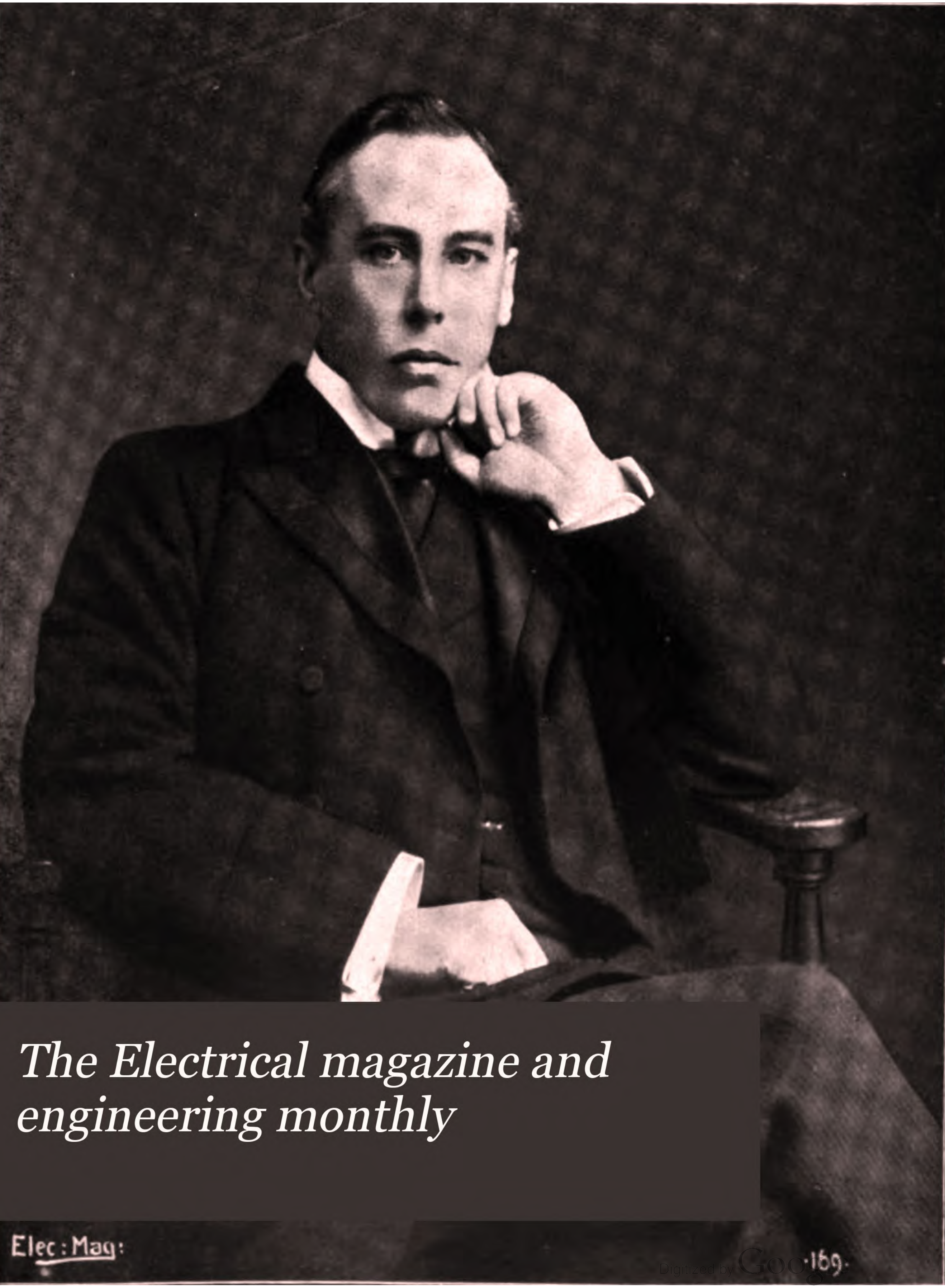
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

The Electrical magazine and engineering monthly



Alfred Hay.

LIBRARY OF THE
UNIVERSITY OF MICHIGAN

DEPARTMENT
OF
ENGINEERING

LIBRARY
TK
1
.E37

The
Electrical Magazine

and engineering monthly.

EDITOR-IN-CHIEF:
THEO. FEILDEN.

ASSOCIATE EDITORS: LEADING AUTHORITIES IN EVERY BRANCH OF ELECTRICAL ACTIVITY.

ACTING EDITOR: W. E. WARRILOW, A.M.I.E.E.

◆

INDEX TO VOL. I.
January to June 1904.

◆

LONDON:
The Electrical Publishing Co., Ltd
4 Southampton Row, Holborn, W.C.

INDEX TO VOL. I.

(Each Section is Indexed separately, and there is no cross Indexing between Sections.)

Leaders.

ELECTRICAL Industry during the past Twenty Years, A Survey of the Advance of, 4
  Industry, The Position of, 225
Electric Railways, The Problem of, 337
National Electric Light Association, The, 561
Our Raison d'Etre, 1
Power Stations, 449
Success, 113

World's Electric Progress. Editorial Commentary of the Month.

ACCUMULATOR, the Edison, 14
A.I.E.E. Annual Dinner, 117
Alteneck, H. von (Further Losses), 120
American and British Mechanical Engineers, 566
American Association for the Advancement of Science, 120
Appreciation and Thanks, 227
Armature Windings, Polyphase, 451
Automatic Telephony, 563
Automobiles, Electro-Petrol, 122
BAKERY, Light (Fulham Bakehouses), 228
Blondlots N-Rays, 124, 453
Bramwell, Sir Frederick, 118
Bristol Disaster, The, 13
British and German Wages, 452
CABLE Telegraphy, 340
Canals, A Use for, 228
Carbons, Electric Light, Anent, 231
Central Station Men, To, 564
Copper, A new Source for, 10
Crystal Palace Show (Automobiles), 227
DUBLIN's Electrical Affairs, 11
EDISON Accumulator, The, 14
Edison Cell, The, 125
Education, Transatlantic Engineering, 123
  German Technical, 344
Electrical Conference, Electrical Standards Committee, 120
  Profession, Openings in, 453
  Testing and Measuring Instruments, 126
Electricity in Egypt, 120
  in the Liaotung Peninsula, 452
  in Mining, 128
  in Mining and Metallurgy, 233
  in Steel Works, 451
  Where, scores, 228
Electric Light Carbons, 231
  Power, Pig Iron and, 342
  Traction on New York Central, 122
  Traction, Main Line, 125
  Traction, what, can do, 565
Electrocutions, Railway, 567
Electro-Galvanising, 123
Electrolytic Iron, 451
Electro-Petrol Automobiles, 122
Electro-Steam Locomotives, 121
European Telegraphs and Telephones, 236
FARES, Halfpenny Tram, 121
Finance, Municipal Electric Lighting, 232
Fire, The Iroquois Theatre, 565
Fires, On, 11
Fiscal Policy, Trade and, 12
Flood Waters, The Utilisation of, 231
Foreign Goods as British, 12
Free Wiring, Maximum Demand and, 235
GALVANISING, On Electro-, 123
German Technical Education, 344
  Wages and British, 452
Gilbert, William, 14
Guernsey Telephones, 228
HALFPENNY Tram Fares, 121
Holborn Exchange, The New, 568
IROQUOIS Theatre Fire, The, 565
Italian Trade with S. Africa, 228
KISMET (Huddersfield Breakdown), 117
LOCOMOTIVES, Electro-Steam, 121
London Traffic Problem, 341, 455, 569
MARYLEBONE, 121
Maximum Demand and Free Wiring, 235
McMillan, W. G., 118
Measuring Instruments, Electrical Testing and, 126
Metric System, The, 342
Mining and Electricity, 128
  and Metallurgy, Electricity in, 233
Mosely Commission, 340
Motors, Continuous *v.* Single-Phase Traction, 452
  Mechanical Ventilation of, 122
Municipalities and Wiring Contractors, 10
Municipal Credit, 124
Municipal Electric Lighting Finance, 232
N-RAYS, Blondlots, 124, 453 (To see or not to see)
New Zealand, Advance, 227
Niagara, A Waterless, 229
Nuisance, Vibration and, 125, 234
Opinions, Golden, 10
Our Insurance Scheme, 339
  New Volume, 563
  Sections, 10
PETROL-Electric Automobiles, 122
Pig Iron and Electric Power, 342
Polyphase Armature Windings, 451
Power House Architecture, 339
  Supply at One Hundred Million Volts, 230
QUIN, R. C., 118
RADIO-ACTIVE Self Luminous Elements, New, 340
Radium, On, 15
Rail, The Third, 12
Railways, The Coming of One-Phase, 229
  Single-Phase, Electric, 340
Risks, Unnecessary, 342
SEE Or Not to See, To (N-Rays), 453
Shocks, High Voltage, protection from, 235
Single-Phase Electric Railways, 340
Single-Phase *v.* Continuous Current Traction Motors, 451
South Africa, Italian Trade with, 228
Standard Nomenclature for D. C. Machines, 13-231
  Screw Threads, 340
Steam, Exit, 229
  Locomotives, Electro-, 121
  Turbine, The Coming of the, 127
St. Louis Exposition, 346-451, 456
  at Night, 569
Steel Works, Electricity in, 451
Student Readers, Important to, 11
  To Our, 230
TECHNICAL Education, German, 344
  Training, 234
  Training, Lessons from America on, 343
Telegrams, Cheap Local, 339
Telegraphone, The, 563
Telegraphy, Cable, 340
Telegraph Instruments, 565
Telegraphs and Telephones, European, 236
  of the United Kingdom for 1903, The, 566
Telephone Extension between England and France, 341
  Future of in Great Britain, 229
  to Flying Machine, From, 565
Telephones, Guernsey, 228
 See also Holborn
Telephone, Present State of in this Country, 232
  Statistics, Remarkable, 564
Telephony, Automatic, 563
Tesla as a Consultant, 117
Thompson, E. (Further Losses), 120
Traction, Electric, on New York Central, 122
  Main Line Electric, 125
  Motors, Single-Phase *v.* Continuous, 452
 See also Zossen
Trade and Fiscal Policy, 12
Traffic Commission, The London, 569
  Problem, London, 341-455
Travelling Troubles, 120
Turbine, The Coming of the Steam, 127
VENTILATION of Motors, Mechanical, 122
Vibration and Nuisance, 125, 234
WAR (Wireless Telegraphy), 117
  and the Wireless, The, 454
What Next (Electricity on Pikes Peak), 542
Windings, Polyphase Armature, 451
Wiring Contractors and Municipalities, 10
  Free, and Maximum Demand, 235
Wireless, The War and the, 454
ZOSSEN Trials, The, 566

2-1-10 B.S.
Rebound 11-16-39

Special Articles.

Allen, P. R., Electricity applied to Mining and Metallurgy, 132, 240, 357, 473, 574
Alternators, The Theory of, A. Hay, 29, 129, 237, 353, 470, 571
Armature Cores, Plain or Toothed, Which? W. F. Davies, 253
Armatures, on the Windings of Alternator. A. C. Eborall, 461
Bignami, E., Two Large Water Power Installations, 143
Blast Furnace Gas Engines. P. R. Allen, 357
Coal Cutting, Electric. P. R. Allen, 240
Davies, W. F., Plain or Toothed Armature Cores, Which? 253
Eborall, A. C., On Polyphase Generators, 17
On the Windings of Alternator Armatures, 461
Electrical Industry, Municipalisation and the. A. G. Whyte, 31
Lifting Apparatus for Iron and Steel Works. A. Reichwald, 364
Electricity Applied to Mining and Metallurgy. P. R. Allen.
I. Winding and Hauling Engines, 132
II. Draining, Coal Cutting, Drilling, 240
III. Blast Furnace Gas Engines, 357
IV. Electrical Machinery in Steel Works, 473
V. Electrical Machinery in Steel Works, Concluded, 574
Electricity, the Application of, on the Oil Fields. L. Gaster, 149 (*See also* Power)
Electro-Magnetic Clutches and Speed Gears. R. Kennedy, 250
Gas Engines, Blast Furnace. P. R. Allen, 357
Gaster, L., The Application of Electricity on the Oil Fields, 149 (*See also* Power)
Generators, On Polyphase. A. C. Eborall, 17
Hay, A., The Theory of Alternators, 29, 129, 237, 353, 470, 571
Hauling and Winding Engines. P. R. Allen, 132
Kennedy, R., Electro-magnetic Clutches and Speed Gears, 250
London, W. J. A., Steam Turbines for Electric Generating Stations, 372
Lozier, R. T., The Individual Motor Drive, 584
Motor Drive, The Individual. R. T. Lozier, 584
Municipalisation and the Electrical Industry. A. G. Whyte, 31
Polyphase Generators, On. A. C. Eborall, 17
Power Installations, Two Large Water. E. Bignami, 143
Reichwald, A., Electrical Lifting Apparatus for Iron and Steel Works, 364
Steam Turbines for Electric Generating Stations. W. J. A. London, 372
Whyte, A. G., Municipalisation and the Electrical Industry, 31
Winding and Hauling Engines. P. R. Allen, 132
Windings of Alternator Armatures, On the. A. C. Eborall, 461

Power.

Address, Introductory. G. W. de Tunzelmann, 36
California, Hydro-Electricity in, 378
Cement Manufacture. Electricity in, 158
Chevres, The Hydro-Electric Station at, 262
Comparison, A (Transmission Lines), 160
Consumers of Electric Power. W. E. Warrilow, 377
Control of Machine Tools, Variable Speed, 261
Cost of Electric Power, 380
Electricity in Cement Manufacture, 158
Direct from Fuel, 262
on the Oil Fields, The Application of. L. Gaster (*See also* Special Articles), 38
Electric Governing of Steam Turbines, 486
Electric Power, Consumers of. W. E. Warrilow, 377
Power, Cost of, 380
Power in Printing. Holmes Clatworthy, 481
Power in Steel Works, 155
Power in Sunderland, 483
Power, Tunnel Ventilating by, 261
Water Supply System, 488
(*See also* Power and Hydro-Electricity)
Foreign Items (Short Notes), 160, 264, 382
Fuel, Electricity direct from, 262
Gaster, L., The Application of Electricity on the Oil Fields, 38 (*See also* Special Articles)
General Power Notes, 159, 263, 381, 488, 596
Home Power Notes, 160, 264, 382
Holmes Clatworthy System (Printing), 481
Hudson River, Water Power from, 595
Hydro-Electricity for Small French Factories, 592
in California, 378
Hydro-Electric Station at Chevres, The, 262
Plants, Roumanian and Swiss, 378
(*See also* Power, Electric Power)
Machine Tools, Variable Speed control of, 261, 264, 382
Montreal Power Scheme, The, 260
Power, Consumers of Electric. W. E. Warrilow, 377
Electric, Cost of, 380
Electric, in Steel Works, 155
Electric in Sunderland, 483
House, West Ham's New, 483
Houses, Some Comparisons in, 258
Plant, A Small British Water, 379
Power Plant, A Small British Water. W. E. Russell, 590
Supply in Bulk in Great Britain. W. E. Warrilow, 153
Water, in the British Isles. W. E. Warrilow, 257
The Montreal Scheme, 260
The World's Greatest Centre of Transmitted, 157
Tunnel Ventilating by Electric, 261
(*See also* Electric Power and Hydro-Electric)
Printing Electric Power in, 481
Office, the largest in the world, and its Electrical Equipment, 154
Pumping with Electric Turbine Pumps, 594
Roumanian and Swiss Hydro-Electric Plants, 378
Russell, W. E., A Small British Water Power Plant, 590
Steam and Water Power Plant, Combined, 158
Turbines, Electric Governing of, 486
Turbine Installations, Further Interesting, 484
Turbines, Some Comparisons in Power Houses, 258
Steel Works, Electric Power in, 155
Swiss and Roumanian Hydro-Electric Plants, 378
Sunderland, Electric Power in, 483
Tanners, Important to British, 379
Tunzelmann, G. W. de, Introductory Address, 36
Turbine Installations, Further Interesting Steam, 484
Turbines, Electric Governing of Steam, 486
Turbine Pumps, Pumping with Electric, 594
Turbines, Steam, Some Comparisons in Power Houses, 258
Ventilating, Tunnel, by Electric Power, 261
Warrilow, W. E., Power Supply in Bulk in Great Britain, 153; Water Power in the British Isles, 257; Consumers of Electric Power, 377
Water Power in the British Isles. W. E. Warrilow, 257
Power from the Hudson River, 595
Power Plant, Combined Steam and, 158
Power Plant, A Small British, 379
Power Plant, A Small British. W. E. Russell, 590
Supply System, Electric, 488
(*See also* Hydro-Electric and Power)
West Ham's New Power House, 483

Power Notes.

American River Co.'s Plant, 381
Atalanta Power Dam, 264
Boston Edison Co.'s Plant, The, 595
Cloth Cutting by Electricity, 596
Composite Plant, A, 263
Direct Current from A. C. Systems, 488
Electric Tree Felling, 40
Electricity, Austrian Railway Workshops, 263
in Japan, 596
in Shipyards, 263
Works, Compressed, 159
Est Lumiere Co. of Paris, The, 488
German Power Plants, 159
Grenoble High Tension Power Scheme, 488
Hoisting without Loss of Energy in Rheostats, 264
Interruption at La Haye, 264
Irrigation by Electricity, 159
"La Houille Blanche," 159
Lachine Rapids Power House, 40
Melting Frozen Pipes, 263
Niagara, Developments at, 159
Power Consumers in British Towns, 139
Discussions before the A.I.E.E., 382
from Glacial Streams, 382
on the Housatonic, 263
at Port Francis, Canada, 381
Line in North-Western States, Longest, 40
Plant at Bilbao, 596
Rates in America, 40
Schemes in New Zealand, 596
Transmission from Amiens to Longeau, 488
St. Louis Service Plant, 263
Short of Water (Brunswick, U.S.A.), 264
Tanning by Electricity, 263
Three-Phase Working, Practical Points on, 159
Tyneside Electrical Pioneer, The, 595
Venezuelan Power Supply, 264
Water Power in the "North Country," 40
Project, A Scotch, 159
Wind Driven Electricity Works, 40
Motors, 381
Winding-Engines, Electric, in a French Slate Quarry, 263
20,000 Volt Transmission Plant, 381

Traction and Transport.

A. C. Potential Fall in Railway Rails, 495
Alternate Current Signals, 270
Arnold Electro-Pneumatic Railway, 166, 383
Article, Introductory. G. W. de Tunzelmann, 41
Automatic Signalling on the District Railway, 49

202603

Battery Locomotives Storage, 604
Braking by Electricity on Tram and Railway Lines, 605
Canal Haulage, 43
  Haulage Devices, Electric. F. C. Perkins, 597
Cars, Regenerative Control of Electric. G. W. de Tunzelmann, 600
Electric Canal Haulage Devices. F. C. Perkins, 597
  Railway, Liverpool and Southport, 387
  Traction for Railways, W. M. Mordey:
    I. Some Considerations and a Warning, 44
    II. The Coming of One Phase Methods, 161
    III. The Coming of One Phase Methods (Contd.), 265
    IV. The Arnold Electro-Pneumatic System, 383
    V. The Oerlikon One Phase System (Contd.), 489
Great Northern and City Tube Railway, 271
Level Crossings on Tramway Lines, 605
Marienfelde-Zossen Line, High Speed Locomotive on, 389
Mordey, W. M., Electric Traction for Railways, 44, 161, 265, 383, 489
Motors, Single Phase Railway, 494
Perkins, F. C., Electric Canal Haulage Devices, 597
Pigg, J., Prospective Changes in Railway Signalling, 46
Railway, the Arnold Electro-Pneumatic, 166
Railways, Electric Traction for. W. M. Mordey
  (*See* Electric Traction)
Railway, The Great Northern and City Tube, 271
  Liverpool and Southport Electric, 387
  Motors, Single Phase, G. W. de Tunzelmann, 494
  Rails, A. C. Potential Fall in, 495
Railways and Tramways, G. W. de Tunzelmann, 270
Regenerative Control of Electric Cars, G. W. de Tunzelmann, 600
Signalling, Automatic, on the District Railway, 49
  Railway, Prospective Changes in. J. Pigg, 46
Signals, Alternate Current, 270
Single Phase Traction, 165
  (*See also* W. M. Mordey)
Single Phase Railways Motors. G. W. de Tunzelmann, 494
Storage Battery Locomotives, 604
Tangential Traction, 166
Tramways and Railways. G. W. de Tunzelmann, 270
Tube Railway, the Great Northern and City, 271
Tunzelmann, G. W. de, Introductory Article, 41; Railways and Tramways, 270; Single Phase Railway Motors, 494; Regenerative Control of Electric Cars, 600
Traction Notes in Brief, 168, 272, 390, 606

Traction Notes.

After the Fire (Paris Metropolitan), 272
Alternate Current Railway Motor, The, 272
Breaking of Trolley Wires, 167
Electricity on the Manhattan Railway, 168
Electric Tramways in Germany, 606
  Traction in London Northern Suburbs, 495
  Traction on Swedish Railways, 390
Everett-Snohomish Interurban Railway, 390
Friburg-Morat-Anet Railway, 496
Ilford Corporation Tramways, 272
Jungfrau Railway, 560
Massachusetts Traction, 272
Meters on Electric Cars, 389
Motors, Predetermination of Temperature Rise in Railway, 272
  Efficient Variable Speed, A. C., 272
Paris-Orleans Electric Railway, 606
Paris Tramways, 606
Rail Bonding, 496
Railroading High Speed, 167
Rails, Resistance of Alternating Current in Railway, 606
Sliding Bow *v.* Trolley, 495
Third Rail High Speed Trials, 272
Trolley Omnibus Experiments, U.S.A., 168
Vesuvius Electric Railway, The, 390
Western Ohio Railway, 496
Wheels for Tramcars, 496

Lighting and Heating.

Address, Introductory, W. H. Story, 51
Arc, The Alternate, 499
  Lamp, Bremer, The, 53
  Lamp, Three Phase, A New, 274
Benard Lamp, The Enclosed, 499
Bremer Arc Lamp, The, 53
Brevities (Home Notes), 174, 276, 394
Cooper Hewitt Converter, The. W. H. Story, 391
  Hewitt Lamp, the Present Position of the. W. H. Story, 273
  Hewitt Lamp in Photography, 392
Electric Heating in the Hat Trade, 274
  Lighthouse in Heligoland, The, 497
Foreign Items, 174, 276
Fountain, A Novel Illuminated, 170
Heating, Electric, in the Hat Trade, 274
Incandescent Lamp, the Beginnings of, 393
Lighthouse in Heligoland, the Electric, 497
Light Projectors, A New System of. G. A. Purves, 607
  Writing in (Sky Sign), 274
Lighting, Cost of Street, W. H. Story, 169
Mercury Vapour, The Conductivity of, 172
  Vapour Lamp, A New Form of, 392
  (*See also* Cooper-Hewitt)
Nernst Lamp, the Life and Efficiency of, 171
  Lamp, Photometric Tests of, 172
Purves, G. A., A New System of Light Projectors, 607
Story, W. H., Introductory Address, 51; Cost of Street Lighting, 169; The Present Position of the Cooper Hewitt Lamp, 273; The Cooper Hewitt Converter, 391
Street Lighting, Cost of. W. H. Story, 169
Testing of Lamps, The, 613
Vapour, the Conductivity of Mercury, 172
  Lamp, A New Form of Mercury, 392

Lighting and Heating Notes.

American Critics, 173
  Experience with Nernst Lamps, 614
Anniversary of the Incandescent Lamp, 25th, 393
Arc Lamp, A New, 500
  Lights for a Canadian Canal, 394
  Lighting, Series, 394
  v. Incandescent Lamp, 275
Belfast Progress, 275
Central Stations, Increasing the Output of, 614
Charging for Electrical Energy, 173
Colour Photometry, 393
Cooper-Hewitt Lamp in Photography, 54
Crystal Palace Gas Exhibition, 275
Dowsing Hot Air Bath, The, 276
Electric Lighting at Southwark, 614
Electricity for the Household, 559
Fire at the Iroquois Theatre, Chicago, The, 276
  Proof Insulation for Cables, 173
Gas *v.* Electricity, 500
Heating Device, A Novel, 174
Illumination, Monolateral, with DC. Arc Lamps, 394
Incandescent Lamp in America, The, 500
Licensed Wireman, The, 500
Miners' Lamp, A Portable, 614
Osmium Lamp, The, 276
Radiators, Efficiency of Electric, 54
Rates for Lighting in U.S.A., 174
Street Lighting, 394
  Lighting by Nernst Lamps, 614
Welsbach Mantle, Why the, becomes dim, 276
World's Fair Supply, 174

Telegraphy and Telephony.

Telegraphy.

Anemometer, Electrical, 507
Baudot on a Cable Circuit, The, 396
  Telegraph, Improvements in the, 505
Cables, The World's Submarine, 280
Clocks, Electrically operated, 505
Mercadier Multiplex Telegraphy System, The, 616
Multiplex Telegraphy System, The Mercadier, 616
Murray Printing Telegraph. J. S. Smith, 59
Printing Telegraph, Murray, The. J. S. Smith, 59
Russo-Japan War (Telegraph Cables), 280
Signalling, Electro-pneumatic, 618
Smith, J. S., The Murray Printing Telegraph, 59
Submarine Cables, The World's, 280
  Mines, 620
Telegraphs, High Speed. E. O. Walker, 615
Telegraphs in 1903, 57
Telegraph in India, Progress in the. E. O. Walker, 501
  Pole Bracket, 177
  Tappings, 180, 510
Teleterograph, The, 618
Teletyper, The, 396
Walker, E. O., Progress in the Telegraph in India, 501; High-Speed Telegraphs, 615

Telegraph Notes.

Automatic and Type-printing Telegraphs, 399
Berlin Type-printing Telegraph Station, 64
Baudot Apparatus, The, 281, 623
Code in Telegrams, 309
Electric Timing on a Toboggan Run, 509
Gutta Percha, A new, 281
New Year's Eve World Wide Time Signal, 180
Philadelphia, New Western Union Office at, 510
Police Telegraphs, 509
Post Office Underground Cables, The, 281
Seeing by Wire, 282
Signalling, Record in S. Africa, 510
Switchboard of the Postal Telegraph Cable Co., Boston, New, 509

Switchboard for Fire Alarms, 399
TELEGRAPH Exchanges, 282
    Magneto, A., 509
    in New England, 623
    Printers, 282
    Revenues, Taxation of, 508
    Supplies for Italy, 309
Telegraphic Work in the Baltimore Fire, 281
Telegraphs and the Tibet Expedition, 281
Telegraphy and Telephony Simultaneous, 560
    in U.S.A., 180
Telescripter, The, 282
Type-printing Telegraph, Rapid, 64
    Telegraph Station, the Berlin, 64
UNDERGROUND Wires, 399
Western Union Office at Philadelphia, New, 510

Wireless Telegraphy.

ANTENNA, Tuning the, 620
CAPILLARY Receiver, A, 176
DETECTOR for Electric Waves, A New Metrical. L. H. Walter, 277
    The Magnetic, 617
INTERRUPTER, The Mercury Vapour, 396
Magnetic Detector, The, 617
MERCURY Vapour Interrupter, The, 396
Paper, A Recent Interesting (Dr. Ives), 278
RECEIVER, A Capillary, 176
TELEGRAPH, Wireless, in 1903
Torpedo boats, Wireless Control of, 175, 571
Transmitter Energy, Increasing the, 506
Tuning the Antenna, 620
WALTER, L. H., A New Metrical Detector for Electric Waves, 277; The Trend of Modern Wireless, 279, 395
Waves, A New Metrical Detector for Electric. L. H. Walter, 277
Wireless Control of Torpedo Boats, 175
    Telegraph in 1903
    The Trend of Modern. L. H. Walter, 279, 395
    Waves, 282, 400, 624

WIRELESS TELEGRAPH NOTES.

COHERER, A Novel, 624
EPHEMERAL Applications, 178
Experts, when differ (Cape Hatteras), 400
HELIGOLAND Wireless Telegraphy, 400
INDUCTION Coils, Resonance, in Wireless Telegraphy, 624
International Communication, 179
(LOFFODEN Islands), Two New Stations, 65
MARCONI Co. and others, The, 400
Military Balloon Trials, 179
NOTABLE French Paper, A, 178
Patent Applications, Anen , 66
POLARISED Wave Experiments, 66
RECORD, An Interesting, 179
Russian Experiments, 179
SYSTEM with New Features, A, 400
    a New, 560
TIMES, The, Enterprise of the, 400
Trains, Experiments with Moving, 66
Transmitters, Practical Tips on, 66
WAVE Meters, On, 179
    lengths measuring, 66
When Experts Differ, 400
Wireless Fire Alarm, 66
    for Italian Mercantile Marine, 179
    Telegraphy, 400
    Telegraphy, A Novel System of, 178
    Telegraphy, Practical Instruction in, 179

Telephony.

AMERICAN Telephone Patents, Recent, 622
Automatic Operating, 397
    Telephones in U.S.A., 502
BATTERY Explorer, A Telephone Exchange Storage, 504
GOVERNMENT Proposal to Buy National Telephone Co., 506
Introductory Remarks, 55
JACK Trouble, Repairing Multiple, 621
MEASURED Service and Party Lines in U.S.A., 398
Multiplex Telephony, A Striking Departure in, 176
NATIONAL Telephone Co., Government Proposal to buy, 506
PARTY Lines in U. S. A., Measured Service and, 398
Post office Trunk Switchboard, 279
Pupin's Invention, American, applications of, 398
RECEIVER, a unique Principle, 621
Repairing Multiple Jack Trouble, 621
Repeater, Another telephone, 507
TELEPHONE Calls, 179, 282, 510
    Patents, Recent American, 622
Telephone, Introductory Remarks, 55
    Exchange Battery Explorer, A, 504
    Problem, How is it to be solved, 280
    Repeater, Another, 507
Telephones, State Purchase of, 397
Telephones in U.S.A., Automatic, 502
Telephony, a Striking Departure in Multiplex, 176
Trunk Switchboard, the New Post Office, 279

TELEPHONE NOTES.

AUTOMATIC Exchange at Lincoln, Nebraska, 622
BELL Telephone Co. borrows 20,000,000 dols., 622
CHEAP Telephones in Canada, 180
    System of Telephone Wires, 623
FIRE in New York Subway interrupts Telephone Service, 508
KEEN Competition in America, 179
MUNICIPALITIES and Telephones, 508
NEWSPAPER utilises the Telephone, 623
Nova Scotia Telephone Figures, 623
PARTY Line Figures, Some interesting, 508
Price, A Question of, 399
RAILROADS Instal Telephone System, 622
TELEPHONES in Hospitals, 507
    in Japan, 180
    in Paris, The, 65
Telephonic Political Convention, A, 65
Training of Telephone Engineers, The, 65

Electro-Chemistry, Electro-Physics, Electro-Metallurgy.

ALUMINIUM, A New Process for Welding, 288
BLONDLOTS N-Rays, 182, 287, 288, 403, 514
BORNS, H., Electro-Chemical Industries, 283
COWPER Coles, S., The Importance of Electro-Chemistry as bearing on the Electrical Industry, 67; Some Notes on Electro-Galvanising, 401; An Electrolytic Process for the Manufacture of Parabolic Reflectors for Search Lights, 511; A New Process for the Protection of Iron and Steel from Corrosion, 625
ELECTRIC Iron and Steel Processes, The. J. B. C. Kershaw, 181
Electro-Chemistry as bearing on the Electrical Industry, The Importance of. S. Cowper Coles, 67
Electro-Chemical Industries. H. Borns, 283
Electro-Chemistry and Electro-Metallurgy, Industrial, J. B. C. Kershaw, 71
Electrodeless Steel Furnace, An, 513
Electro-Galvanising, Some Notes on. S. Cowper Coles, 401
Electro-Physical Research. G. W. de Tunzelmann, 69
Electro-Physics during 1903, Some Notes on the Principal Advances in, 72
Electrolytic Process for the Manufacture of Parabolic Reflectors for Search Lights, An. S. Cowper Coles, 511
GALVANISING, Electro, Some Notes on. S. Cowper Coles, 401
IRON and Steel Processes, The Electric. J. B. C. Kershaw, 181
    and Steel from Corrosion, A New Process for the Protection. of. S. Cowper Coles, 625
KERSHAW J. B. C., Industrial Electro-Chemistry and Electro-Metallurgy, 71; The Electric Iron and Steel Processes, 181
N-Rays (*see* Blondlots)
STEEL Furnace, An Electrodeless, 513
TUNZELMANN, G. W. de, Electro-Physical Research, 69; Blondlots N-Rays, 182

ELECTRO-PHYSICAL NOTES.

ALTERNATE Current Bridge Measurements, 630
Arcs, Electric, Conditions controlling the Production of, 406
    Electric, Between Mercury and Carbon, 630
    in Exhausted Tubes containing Metallic Vapours, 40
    Lamps, Contribution to the Differential Theory of, 630
Atmospheric Radio-Activity, 405
Atoms, Structure of, 405
BLONDLOTS N-Rays, 72
CATHODE Rays through Metals Passage of, 288
Cores in Coils, on the Role of Metallic, 630
DIELECTRIC Capacity of Atoms, 516
Electricity in Flames, conductivity of, 516
ELECTRODELESS Annular Currents, On, 515
    Discharge, 184
Electrodes of an Electric Spark, On the Pressure exerted on the, 516
Electron Theory, Metallic Conduction on the, 184
Electrostatics, Electric conductivity in the field of, 515
Ether, Double Refraction in Matter moving through the, 516
GALVANOMETER, The Chord, 289
HERTZ Grating Experiment, The, 404
Hysteresis, Suppression of, 184
INDUCTION of Currents, The Influence of the Medium on, 290
Insulators emersed in Electrolytes, Electric Field of, 515
Ionisation produced in Gases by Röntgen Rays, 405
KATHODE and Canal Rays, 404
Kathodes, Use of Rapidly Rotating, 184
LECLANCHE Dry Cell, 515
MAGNETIC Constants, The Measurement of, 515
Metals, Relation between Optical and Electrical Qualities of, 404
POWER Factor Meter, 405
RADIATION Phenomenon, On a Novel, 289
Radioactive Emanations from Water and Oil Fountains, 515

Radioactive Phenomena, Theory of, 290
Radio-Activity, 72
  Atmospheric, 405
Radium, Action of, on Vacuum Tubes, 289
  Glass, Quartz and other Bodies, 406
  Cooling of Bodies heated and electrified under the Influence of, 288
  Degradation of into Helium, 183
  Energy of, 405
  Emanations, 405, 629
  Heat given off from, 290
  Lines, Magnetic Decomposition of, 404
  Motion of in the Electric Field, 405
  and Ozone, Facts on the Luminous Phenomena due to, 406
  Rays, Action of on Explosive Potentials, 184
Richard Cinemometer, 289
SELENIUM Cell, The, 184
  The Conductivity of, 184
THEORY of Differential Arc Lamps, The, 630
Thermo-Electric Forces and Heated Wires, 406
WAVES, Electric, In High Capacity Self-inductive Systems, 289

Students' Section.

ADDRESS, Introductory. A. Hay, 73
Alternate Current Working, 635
Alternating Current Series Motor, 411
Apprentices, The Training of, 74
BIGNAMI, E., Montefiore Technical Institute, 291
CONVERTERS, Rotary, 521
CRAPPER, E. H., Principles of Polyphase Currents, 185; Problems in Dynamo Design, 296, 407, 517, 634
DYNAMO Design, Problems in. E. H. Crapper, 296, 407, 517, 634
ELECTRICAL Measurements, 522
Electro-Magnetism, The Foundations of, A. Hay, 294, 409, 519
HAY, A., Introductory Address, 73; The Foundations of Electro-Magnetism, 294, 409, 519; Some Illustrations of Approximate Methods of Solving Problems, 631
MONTEFIORE Technical Institute. E. Bignami, 291
NOTES, 297
PRINCIPLES of Polyphase Currents. E. H. Crapper, 185
Problems in Dynamo Design, 296, 407, 517, 634
Problems, Some Illustrations of Approximate Methods of Solving. A. Hay, 631
Professor to Student, From, 191, 298, 412, 522
RESISTANCES, Comparisons of Low, 412
Rotary Converters, 521
Students, I.E.E., Visit to Birmingham, 559
TRACTION Systems, of the Future, Long Distance, 189
Training of Apprentices, The, 74

Manufacturers' Section.

ACCUMULATORS (Crystal Palace Show), 310
ADDRESS, Introductory. W. N. Twelvetrees, 75
Astatic Wattmeter, An, 78
Alternator, The Helios 3,000 KW., 420
Alternators, Testing Large, 302
Blue Printing Machine, A New, 197
BOURNEMOUTH Electrical Exhibition, 416
Brake, The B.T.H. Electro-Magnetic Track, 418
CABLE Construction in Germany, Industrial Electric, 530
Capstans, Electric, at the Port of Antwerp, 195
Ceiling Rose, A New Porcelain, 644
Centrifugal Pumps, Vertical, 524
Coal Conveyers for Electricity Works, 529
Coal Cutting Machines, Electric, 198
Compressors, Motor Driven Air, 304
Conduit System, The Howard, 197
Crane, Electric Power, 79
Cranes, Dock Luffing, 306
DIRECT Current Pressures and Frequencies, Standard, 83
Dynamos in Germany, Construction of, 421
Dynamo and Motor Tests, Erroneous Thermometer Readings in. W. N. Twelvetrees, 413
ELECTRICAL Driving. W. N. Twelvetrees, 523
Electricity at the Crystal Palace Automobile Show, 308
Electromagnetic Track Brake, The B.T.H., 418
Electro-Enamel, Insulating Varnishes, 644
Engine, A New High Speed Triple Expansion, 415
Estimates, Competitive. W. N. Twelvetrees, 192
FAN, Cyclone Electric, 642
  A New Motor Ventilating, 303
Frequencies, Standard Direct Current Pressures and, 83
Fuse Box, The Callendar Ward, 305
Fuse, The Sparklet H.T., 529
GENERATORS, Low Voltage, 422
  Electrical Industries, 307
Graham Morton and Co.'s Works, 638
Induction Motors, 80
Ignition Devices (Crystal Palace Show), 311
Instruments, Lamp Testing, 304
  Measuring, 307
Insulating Varnishes, Electro-enamel, &c., 644
Integrating Wattmeter, The Ferranti, 77, 644
Inventors, A New Use for, 559
LAMP-Shade, A Novel, 197, 306
Lamp Testing Instruments, 304
Linolite, 417
Locomotives, Electric, 414
METER Screw, A New Diamond Bearing, 530
  Cut for Machine Tools, 643
Milling Machines Electrically Driven, 422
Motor Driven Air Compressors, 304
  Double-Gear Milling Machine, 421
  Driven Fire Pumps, 84
  Generator Set, A Vertical, 526
  Single Phase Repulsion, Speed Torque Characteristics of, 527
  Starting Panel, A New Form of, 642
  Ventilating Fan, A New, 303
Motors, Induction, 80
  Steel Clad, 642
PLUG and Socket, A New Combination, 422
  A New Wall, 307
Power Factor Meter, A New Portable, 528
Pulley Block, An Electric, 64
  Patent Ring, 199
Pump for Hot Water Electrically Driven, 304
Pumps, Motor Driven Fire, 84
  Vertical Centrifugal, 524
Pyrometers, Electric, 82
REIDLER-STUMPF Steam Turbines, 419
Relay for D.C. Circuits, Reverse Current, 640
Repulsion Motor, Single Phase, Speed Torque Characteristics, 527
Reverse Current Relay for D.C. Circuits, 640
SHADE, A Novel Lamp, 197, 306
  Shafting Device for Centring, 528
Slide Rule for Hot Climates, A, 199
Smoke Consumer, A New, 421
Speed Indicators, 306
  Torque Characteristics of the Single Phase Repulsion Motor, 527
Standards Committee, The Engineering. W. N. Twelvetrees, 299
Standard Direct Current Pressures and Frequencies, 83
Steam Turbines, High Power Westinghouse, 304
  Turbines, Reidler-Stumpf, 419
  Westinghouse Vertical, 526
Stop Valves, Equilibrium, for High Pressure Steam, 416
Surface Contact System, The "G. B.," 193
Switch, A New Lock Push, 305
Switches, High Potential, 196
  High Voltage Oil, 644
TARIFF Meters Systems, The Double, 300
Testing Large Alternators, 302
Thermal Storage for Steam Boilers W. N. Twelvetrees, 637
Transformers, German Three Phase, 199
Turbines, Steam High-Power Westinghouse, 304
  Steam Reidler-Stumpf, 419
  Westinghouse Vertical Steam, 526
Trolley Base for Tramcars, The Kennington and Fawcett
TWELVETREES, W. N., Introductory Address, 75; Competitive Estimates, 192; The Engineering Standards Committee, 299; Erroneous Thermometer Reading in Dynamo and Motor Factor, 413; Electrical Driving, 523; Thermal Storage for Steam Boilers, 637
VEHICLES, Electric, Crystal Palace Show, 308
Ventilating Fan, A New Motor, 303
  (*See also* Fan)
WATTMETER, An Astatic, 78
  The Ferranti Integrating, 77, 644

Central Station Practice.

ADDRESS, Introductory, 85
Artificial Loads for H.T. Three Phase Generators. J. P. Kemp, 86
BOILER Surfaces, Cleaning, 426
Bristol Fire, The, 201
CENTRAL Stations, Fire Risks in, 200
  Station Organisation, 313
Circuit Breakers, Fuses V., for Protecting High Potential Circuits. W. S. Toplis, 531
  Breakers, Hints on, 424
CLEARY, J., Faults on Underground Mains, A Remedy, I., 651
Coal, Burning Pulverised, 537
Connections, Three Phase Transformer, On, 315
CORSON, F. H., Notes on the Working of Central Station Plant, I. 644
DESTRUCTORS, Refuse, and Electricity Works. F. L. Watson, 423
Distributing System, The Removal of Faults on the, 314
FAULTS on the Distributing System, The Removal of, 314
  on Underground Mains, A Remedy, I. J. Cleary, 651
Feed Water Heater Arrangement, 426

Fire, The Bristol, 201
  Risks in Central Stations, 200
Fuses *v.* Circuit Breakers for Protecting High Potential Circuits. W. S. Toplis, 531
Generators, Artificial Loads for H.T. Three Phase. J. P. Kemp, 86
Kemp, J. P., Artificial Loads for Three Phase Generators, 86
Mains, Underground, Faults on, A Remedy, I. J. Cleary, 651
Mechanical Stokers. F. H. Whysall, 645
Plant, Central Station, Notes on the Working of, I. F. H. Corson, 649
Pulverised Coal, Burning, 537
Refuse Destructors and Electricity Works. F. L. Watson, 423
  Steam from, and its Cost, 425
Rheostat, A Novel, 538
Station, Central, Organisation, 313
  Plant, Central, Notes on the Working of, I. F. H. Corson, 649
Steam from Refuse, and its Cost, 425
Stokers, Mechanical. F. H. Whysall, 645
Switchboards, The Care of, 202
Toplis, W. S., Fuses *v.* Circuit Breakers for Protiecton of High Potential Circuits, 531
Transformer Connections, on Three Phase, 315
Underground Mains, Faults on, A Remedy, I. J. Cleary, 651
Watson, F. L., Refuse Destructors and Electricity Works, 423
Whysall, F. H., Mechanical Stokers, 645

CENTRAL STATION NOTES.

Cable Conduit, A Large, 316
Calculation of Costs, 91
Coal Deterioration, 316
Earthing the Neutral Point of Rotary Converter Plants, 652
Economiser, The Use of the, 92
Fireman, What is a, 86
Naked Leads for Heavy Currents, 92
Networks, Rational Design of Current Distributing, 538
Substation, A Portable, 92
Suggestion, A, 316
Voltage Disturbances when Paralleling Dynamos, 652

Electrical Work in the Shops.

Angle Plate for Laying out Work, Handy, 205
Bearings, Machining Half, 540
Belt Hints, Useful, 94
Belt, Lacing, A, 205
Boring Bar, A Self-Clearing, 205
Commutators, Making Small, 204
Commutator Tip, A, 654
Crane Tips, Some, 318
Curzon, S. A., The Premium System, 427
Electrical Apparatus, The Care of, 653
Foreword. W. E. Warrilow, 93
Grinder, A Cheap Tool Post, 540
  A Handy Electric, 317
  An Electric, 539
Machining Half Bearings, 540
Milling Attachment, An Internal, 428
  Machine, Two Different Jobs on the Same, 428
Premium System, The. S. A. Curzon, 427
Punches, To Hold Round, 205
Specialising, 654
Tap, Getting out a Broken, 428
Tool Post Grinder, A Cheap, 540
Warrilow, W. E., Foreword, 93

Electrical Trade and Commerce.

Brevities, 432
Business Items, 543
  Opportunities Abroad, 544
Canada, the Effects of Preferential Tariff with, 541
  and Preferential Tariffs, 319
Combinations in Germany, Electrical, 206
Contracts of the Month, 100, 209, 322, 432, 543, 657
Egypt, Electrical Plant wanted in, 206
Electrical Combinations in Germany, 206
  Goods Exported during March and April, 1904, 544
  Industry, The German, 655
Fiscal Problem, The, 95, 319
German Electrical Industry, The, 655
Germany, Electrical Combinations in, 206
Machinery, The Rating of, 42
Mexico, Opportunities in, 542
Preferential Tariffs, Canada and, 319
  Trade, The Effects of with Canada, 541
Rating of Machinery, 429
Tariffs, Canada and Preferential, 319

Tenders Invited, 322, 432

GENERAL TRADE NOTES.

Alexandria, Imports of Electrical Apparatus to, 430
Allis Chalmers Co., The, 431
American Electrical Exports, Some Significant Figures of, 100
American Manufactures, 209
  Firm, An Enterprising, 209
Australia, Electrical Trade in, 656
Belgian Tramway Co., A New, 656
Belliss Engine Contracts, 207
Canadian Company, A New, 209
  General Electric Co., The, 543
Chili, The Development of, 321
Coal Exports in 1903, 321
Commercial Enterprise on the Continent, 321
Contracts of the Month, 100, 209, 322, 432, 543, 657
Coventry, Extensions at, 207
Exhibition Contract, 320
Foreign Trade, Our, Fairly Satisfactory Figures, 207
Fulham, Progress at, 208
General Electric Co., U.S.A., 208
German Electrical Industries, 208
Germano-American Co-operation, 208
Germany, Electrical Engineering Industry in, 656
  Electrical Industry in, 656
Home Trade Notes, 322, 431, 657
Imports of Foreign Electrical Machinery and Apparatus, 430
Installation, A New Manufacturing, 208
Johannesburg, A New Power Station for, 430
Large Shipments (Telephones, U.S.A.), 99
L.C.C. Rails from British Makers, 99
Leicester, Electric Tramways at, 656
London Underground Railways, 430
Madras Electric Tramways, 1904, Ltd., 431
Marine Electrical Work, 207
Melbourne Tramways, 656
Mexico, Power Transmission in, 209
Newcastle, New Generating Set for, 320
New York Central, Large Orders for, 99
  Street Lighting Tenders for, 209
New Zealand, Tramway Contracts in, 656
Railway, Electric, Important Contract to a British Firm, 100
Rubber, Production of, 99
Russian Electrical Exports, Restrictions on, 99
Siam, Opening for Trade in, 657
Spain, State of Electrical Industry in, 321
St. Louis World's Fair, 320
Sturtevant and E. T. C. Amalgamation, 320
Sweden, Duty on Electrical Machinery in, 542
Telegraph Cables and Apparatus, 208
Union Company, Absorption of the, by the Allgemeine Co., 650
United States Electrical Exports, 208
Ventilation of the House of Commons, 430
Water Power Plant for Elgin, 207
Westinghouse Works and the Fair Contracts Clause, 320
Whitechapel, Extensions of Electrical Plant at, 208

Electric Finance and Legislation.

Bill, The Electricity Supply, 658
  The New Light Railways, 660
  The North Wales Power, 660
Bills, Fate of the Power, 546
  for the Coming Session, 211
Brevities, 326
Commission, The London Tariff, 210
Electric Lighting Extensions, Municipal, 326
  Railway Returns, London, 323
Electrification of Main Line Railways, 433
Electricity in Bulk, 212
  Supply Bill, The, 658
Indebtedness, Local, 545
Introductory Remarks, 101
L.C.C. as Obstructionist, 434
Legislation, Prospective Matters, 210
Light Railways Bill, The New, 660
Lighting Extensions, Municipal Electric, 326
Main Line Railways and Electric Tramways, 32
Marylebone Fiasco, The, 211
Municipal Electric Lighting Extensions, 326
North Wales Power Bill, The, 660
Parliament in 1904, 210
  An Important Issue for, 211
Parliamentary Matters, 434
Power Bills, The Fate of, 546
Provisional Orders, Transfers of, 326
Railways, Electrification of Main Line, 433
Tramways, Main Line and Electric, 324

FINANCIAL NOTES.

Assessment of Electric Tramways, 662
Brighton, 662
Bristol, 662
Car *v.* Bus, 547
Central London Traffic Returns, 213
Change, A Welcome, 213
Contrast, A, 213
Dividends, Some, 436

Electricity Supply in London, 661
Fair Play (Glasgow Telephones), 661
Farnworth Finance, 548
Fog, No, But Good Dividends (London Companies), 325
Glasgow Corporation, 436
Hull, 662
Ireland Forward, Electric Lighting Prospects, 213
Issue, A New (Johnson and Phillips), 661
of Capital, A Successful (Newcastle E.S. Co.), 661
L.C.C. Tramways, 547
Leeds Electrical Undertakings, 661
Liverpool Overhead Railway, New Issue, 213
Local Authorities, The Conflicting Interests of, 436
London's New Tube, 213
United Tramways, the Case of, 325
Manchester, 662
Motor Cars on Railways, 324
Motors on Hire or Hire Purchase Systems, 326
Municipal Blackmail, 325
Combination against Running Powers, 548
Compensation for Accidents, 213
Undertaking, A Progressive, 213
Newcastle-on-Tyne, Progress at, 548
Northern Lights (Aberdeen), 213
Parcels on Tramways, 548
Railways and Tramways, Rating of, 324
Runcorn Provisional Order, 548
Sinking Funds in Electrical Undertakings, 325
South African A.E.G., The, 325
Branch of the A.E.G., 213
Standing Orders, Oppressive, 326
Stoke-on-Trent Electric Lighting Loan, 213
Tariff Commission, Electricity Represented, 12
Tramways in the City, 547
Parcel Delivery, 326
Tunbridge Wells, 662

New Electrical Patents.

Alternate Current Motors (Fynn), 104
Systems for Controlling (Scott), 105
Field Magnets for (Finzi), 327
Current Systems and Switches (Reider), 214
Arc Lamps, Automatic Shunting Switch for Protecting the Shunt Coils and Carbon Holders of (Eckstein and Angold), 215
Asynchronous Alternating and Three Phase Current Electric Motors and Rotary Converters, Regulation of (Johnson), 326
Brakes, Improvements in, for Electric Train Cars (Vickers and Andrews), 664
Cable Terminal Boxes for Electricity Supply Purposes (Wilkinson), 104
Clutches, Magnetic (Carolan), 105
Coin Freed Electricity Meters, Improvements in (Beaumont), 438
Field Magnets for A.C. Motors, 327
Filament Lamps, Switching Mechanism for Double (McCullough) 549
Furnaces, Electric, An Improved Method of Melting Steel in (Reynolds), 438
Fuse Pillar Boxes, Electric (Callender Ward), 215
Gas Turbines (*See* Steam Turbines)
Instruments, Electrical Measuring (Chamberlain and Hookham), 214
Lamps, Double Filament Switching Mechanism for (McCullough), 549
Mercury Vapour Means for Operating (Weintraub), 327
Locomotives Electric (Swinburne), 215
Magnetic Clutches (Carolan), 105
Devices, for Cranes, Hoists, Winches (Reichwald), 663
Measuring Instruments, Electrical (Chamberlain and Hookham), 214
Mercury Vapour Electric Lamp, Means for Operating (Weintraub), 327
Meters, Electricity Improvements in Coin Freed (Beaumont), 438
Motors and Regulating Devices for Electrically Propelled Vehicles (Raworth), 438
Electric, and Regulating Devices for Railway Trains or Electric Vehicles, Improvements in (Raworth), 664
Oscillations, *see* Waves
Points, Electrically Operated and Switches for Electric Railways (Breedlove and Grant), 550
Signalling Apparatus for Railways, Automatic (Labarthe), 105
Smoke Consuming, Means for Promoting Combustion and, in connection with Steam Generator Furnaces (Booth and Davis), 215
Steam Turbines (Stumpf), 215
Turbines and Gas Turbines, Electro-magnetically Operated Apparatus for Controlling the Inlet Devices of (Reuter), 662
Vehicles, Electrically Propelled, Regulating Devices for (Raworth), 437
Electric, Improvements in Electric Motors and Regulating Devices for Railway Trains or (Raworth), 664
Waves, An Apparatus for Determining the Length of, and Observing Oscillations in Electric Oscillation Systems, 328
Reviews of Books, 106, 216, 329, 439, 551, 665
The World's Electrical Literature, 108, 219, 332, 444 554, 667
New Catalogues, 110, 223, 335, 447, 557, 671
Forthcoming Events, 112, 224, 336, 448, 558, 672

Authors' Index.

(This List is a key to the Sections in which Authors and Associate Editors are to be found.)

Allen, P. R., Special Articles
Bignami, E., Special Articles, Students
Borns, H., Electro-Chemistry
Crapper, E. H., Students
Clearly, J., Central Station Practice
Corson, F. H., Electrical Work in Shops
Cowper-Coles, S., Electro-Chemistry
Curzon, S. A., Central Station Practice
Davies, W. F., Special Articles
Eborall, A. C., Special Articles
Gaster, L., Power, Special Articles
Hay, A., Special Articles, Students
Kennedy, Rankin, Special Articles
Kemp, J. P., Central Station Practice
Kershaw, J. B. C., Electro-Metallurgy
London, W. J. A., Special Articles
Lozier, R. T., Special Articles
Mordey, W. M., Traction and Transport
de Pass, E., Patents
Pigg, J., Traction and Transport
Purves, J. A., Lighting and Heating
Reichwald, A., Special Articles
Russell, W. E., Power
Smith, J. S., Telegraphy and Telephony
Story, W. H., Lighting and Heating
Tunzelmann, G. W. de, Power, Traction and Transport, Electro-Physics
Twelvetrees, W. N., Manufacturers
Toplis, W. S., Central Station Practice
Walker, E. O., Telegraphy and Telephony
Walter, L. H., Telegraphy and Telephony
Warrilow, W. E., Power, Electrical Work in Shops
Watson, F. L., Central Station Practice
Whysall, F. H., Central Station Practice
Whyte, A. G., Special Articles

"*Whatsoever thy hand findeth to do, do it with thy might.*"

An Explanation.

It will not be out of place for me to proffer in this, the initial number of *The Electrical Magazine*, a few words, in a personal sense, to my readers; in fact, I feel that it is in a manner essential. I can say, with no attempt at egotism, that the electrical fraternity have been looking forward with an exceptional degree of interest to the advent of this publication for some time past, ever since, in fact, I made the announcement that I had formulated a plan for an Electrical Magazine about two years ago. To certain minds, a period of nearly two years may seem an abnormally long time wherein to promote and bring to fruition an enterprise of this character, and a great many people may exclaim, "What on earth has been going on in the interim? We expected and wanted this publication long before this." Just so; those are the ignorant people; ignorant, I mean, in no offensive sense—perhaps a better word would be the "uninitiated."

I feel that this is a matter for plain speaking, affecting, as it does, the interests of a large number of gentlemen who have given me their support in this venture financially and commercially. The organisation of *The Electrical Magazine* is of a peculiar—I might almost say, of an unique—character. There is no association of interests precisely like it in this country. Those concerned in its success embrace at once, not only every branch of the electrical profession and business, but large and small users of electricity throughout the United Kingdom. In a word, I claim that it is the representative publication of the coming power, subscribed to, in the broadest sense of the term, by representative men. To effect this consummation needs something more than sitting down at one's desk to think out an idea—or rather, an ideal—and thereafter, as quick as may be, to get it launched to *its* public. It requires something more than even concentrated thought—that serious, nervy, mental effort which all journalistic enterprises naturally involve. It necessitates work—I might say labour—long, arduous, and consistent, of a character which none but those who have essayed to establish a revolutionary publication can in the slightest degree appreciate. When that publication is of a practical and technical nature, and lays itself out to represent in an efficient manner the interests embraced by the greatest minds in the realms of scientific thought and progress, it resolves itself into a task which I can say, without the slightest semblance of exaggeration or self-glorification, the average man would stand appalled at after having got through the first experience of his "baptism of fire" in this connection. Were this an ordinary paper, catering for the general public, these remarks would be superfluous and unnecessary; but having regard to the fact that the large proportion of its readers are personally, in one way or another, interested in its establishment, that a pernicious, but unsuccessful, attempt has been recently launched against this organisation, and that thereby certain misconceptions appear to have arisen in regard to the non-appearance of the Magazine ere this, I feel it my bounden duty to deal with the matter.

Herein I would like to observe that the man who thinks that he can run a paper, be it technical or otherwise, without the knowledge of the essentials for its proper foundation, deserves to lose what money he or his friends provide for it—but, it is hard on his friends. He may be an enthusiast and a worker, but he is not a thinker, he is not practical, he simply "rushes," and is a fool for his pains, which, in the light of experience and sober reflection afterwards, he doubtless finds out. But so curiously are what is generally taken for brains, common sense and enterprise blended that no amount of reasoning will convince some people that though time, to an extent, may be the essence of the contract, it is in the highest degree unwise to *force* time in matters where work is to follow in sequence and to be prosecuted with system, care and knowledge. We all have to take chances in this world, or nothing would be done and progress would be immediately arrested. But there are opportunities and opportunities, and the wise man is he who, whilst taking Time by the fore-lock, primarily ascertains that that venerable personage does not strangle him in the attempt. "Make haste slowly" is a phrase of value in this connection. If I may take another simile—the man who thinks he can usurp the functions of the captain of a ship, and directs that it should proceed faster without possessing even the rudimentary knowledge necessary, or the right to justify an opinion, deserves to be put in irons or to be thrown overboard. There's no value in his enthusiasm. He's simply a menace to the ship, its owners, and its freight.

Having delivered myself of this little homily, I will be more specific. I originated the idea of this publication as far back as 1899,—almost immediately, in fact, after I launched *Feilden's Magazine*, but the opportunity was not ripe for producing it. On resigning my position, early in 1902, as Editor-in-Chief of the aforesaid journal, I proceeded to put my ideas for *The Electrical Magazine* into execution. These ideas covered a plan which I thought capable of realisation, *viz.*, to secure the co-operation of the electrical fraternity throughout the country in the launching of this enterprise, which, from its inception, I realised could be made of real national benefit and importance. To obtain the needed co-operation was not the work of five minutes. Many months of persistent and consistent endeavour were absorbed. Old prejudices had to be broken down and a new train of thought substituted, and in order to effect this in a comprehensive and complete manner, the task was one of some magnitude. Perhaps if this publication had been initiated in the United States, the work of conversion to new ideas would not have been so gradual or so difficult of attainment, but in conservative England the pioneering of an enterprise of this character is an essentially different matter. In the result, however, I secured such a body of approval as convinced me that I was on right lines. This endorsement of my scheme came alike from men whose names stand high on the scroll of fame in scientific, engineering and commercial circles down to the student worker and artisan. The encouragement thus afforded took more practical shape at the proper time, —a little over twelve months ago. Thus the organisation was formed. Then commenced the hard, plodding, dogged work of building up the edifice of the paper upon the foundations laid. Feeling that a great trust had been placed in my hands, I was all the more determined that this publication should not falsify its pretensions or disappoint its supporters. Step by step the fabric had to be erected with care and discretion. A false move, undue haste, might mean disaster. *The Electrical Magazine* could not be put on the market until the last finishing touches had been effected which would stamp it with the hall-mark of stability and success. *Experientia docet.*

I was not surprised to receive outside criticisms from quarters where "the green-eyed monster" of jealousy was curiously exemplified, tending to discount the enterprise. In this connection, I hesitate to advertise a publication the writer of whose personal notes I estimate at the same value as the literary excellence of the notes themselves, and the good taste that actuates them. It is a curious commentary, however, on human affairs, that obstructive, illogical and absurd tactics sometimes emanate from a source where human intelligence urges that common sense would suggest an opposite course. It is within the knowledge of the electrical world that, just as the organisation for launching this magazine had got fairly settled down, and the matter for the first number was practically ready for the printer, just when every moment was doubly precious, an ill-advised and reprehensible action was promulgated against the company owning *The Electrical Magazine.* Such proceedings, characterized by an appalling degree of senselessness, could, in the eyes of all thinking people, only have one result. This result was attained in due course, but at what an expense of valuable time and effort which could have been more usefully employed in other directions! It seems a pity to me that some tribunal does not exist in this country to test the right of a man to institute proceedings before he is allowed to set the law in motion. The ancients had a summary way of dealing with these matters. They had a civic test examination, and if a man were found to be seeking legal proceedings with *malice prepense,* or from pique or jealousy; in fact, if he had a fancied grievance, or pressed an illogical and senseless suit, he suffered condign punishment. But we are wiser in these days; there are so many lawyers in Parliament, the legal fraternity must be kept going and the machinery of the law well oiled.

I should not have referred to the matter, but that a report appeared in the electrical papers at the time which presented only the case for the plaintiff, simply and solely because the learned Judge summarily shut the whole thing down and dismissed the action with costs before arriving at the defence. Had the case gone on it would have been shown how strong a hold *The Electrical Magazine* had secured, what a far-reaching organisation had been formed, and how utterly false and misleading were the statements so ingeniously made, exceeding even the ordinary limits of inaccuracy taken by over-zealous litigants. Enough said; after all it is a question of the best man winning if he can stay the pace; in other words, the survival of the fittest,—but it is "burning daylight."

In conclusion, I sincerely hope I have not wearied my numerous friends and readers with this recital. I have only to add that the time, strenuous thought and work I have devoted to this magazine, involving a degree of brain-racking anxiety and worry which only those who pursue the profession of journalism can appreciate, has achieved a consummation which I am not ashamed of, and this issue is sufficient reward. Future numbers will exemplify more and more the special utility and characteristics of a publication which I venture to affirm marks a new era in electrical journalism. "Thoroughness" will be the watchword of *The Electrical Magazine,* and by the exemplification of that quality I hope to distinguish it, and make it worthy of the great interests it represents.

Theo. Feilden

One or two TYPICAL OPINIONS out of many hundreds received by the Editor of The Electrical Magazine from influential quarters. . . . . .

From ***Sir W. H. Preece, K.C.B., F.R.S., Past Pres. Inst. C.E. and Inst. E.E.***

I am sure there is
a future for you

Yours truly
W. Preece

From ***Chev. G. Marconi, M.I.E.E., &c.***

"Such a Magazine should be of great general utility, and render considerable service to all who are interested in the progress of Electrical Science."

G. Marconi

From ***Mark Robinson, Esq., Past Mem. Council Inst. E.E.***

"I shall be glad to subscribe for *The Electrical Magazine* which ought to be of great value to those engaged in Electrical work."

Faithfully Yours
Mark Robinson

From ***J. Clifton Robinson, M.I.E.E., &c.*** *(Managing Director, London United Tramways, Ltd.)*

"I appreciate to the full all that you accomplished in the cause of Electric traction under your able and progressive Editorship of *Feilden's Magazine.* In the interests of British Electrical Science and Industry I believe that at the moment the very widest opportunity presents itself for a publication on the basis you have outlined."

J Clifton Robinson

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

No. 1. Vol. I. London. January 21. 1904.

Our Raison d'Être.

THE *ELECTRICAL MAGAZINE* is called for by the new condition of things. The growth of the electrical industries, the national trade exigencies, and the stress on the time of the busy professional man and electrical engineer demand it.

Those who move with the times know what gigantic strides the electrical industries have made of recent years and the position they are likely to assume in the industrial and commercial world. Progress is now so rapid that, figuratively speaking, what was an astonishing revelation yesterday is eclipsed by some new and wonderful discovery or development to-day, and the marvels of electricity are by no means exhausted. We are, as it were, on the fringe of a new era: as the 19th century has been christened "The Age of Steam," so will the 20th most assuredly be known as "The Age of Electricity." There is even now hardly a part of our lives that this vital force does not enter into.

The advance of the electrical business in Great Britain is best shown by the growth of capital held in various undertakings owned by public companies and municipalities. In 1896–7 there were existing 172 electrical undertakings, with an aggregate subscribed capital of £61,109,525. The number has risen in 1903–4 to the astonishing figures of nearly 2,300 concerns, possessing a total subscribed capital of £226,926,938. Of these undertakings, the increase in the aggregate capital of those purely devoted to manufacturing is shown thus:—1896–7, £6,596,244; 1903–4, £35,768,001. These figures (which do not include the large sums employed by numerous private firms, multiplying day by day) bear eloquent testimony to the magnitude, scope, and phenomenal advance of the electrical industries in this country. The figures for the United States, Germany, and other foreign countries are not immediately available, but must reach mammoth proportions.

These great interests, which directly affect not only the thousands who are engaged in electrical work and research in all its branches, but the ever increasing number of users of electricity, have not hitherto possessed any high-class organ which can claim to be a concise and comprehensive world's record of things electrical. That such a publication is wanted, indeed, imperatively and urgently necessary, is abundantly manifest. It is a matter of sheer impossibility for the busy man of to-day, with the ever increasing demands upon his time, to adequately deal with the heterogeneous and imposing body of literature treating upon electrical subjects which emanates from the press of this and other countries. Thus, he more often than not loses something which would be of value to him in his profession or business. *The Electrical Magazine* takes the field to enable him to readily keep pace with the advance of electrical science and progress. It is essentially a *time-saver* and eminently practical. Apart from its distinctively original matter, contributed by the most eminent authorities of the day, its expert staff will collate, co-ordinate and epitomise or indicate, the chief contents of every electrical publication issued. Further, it will present in an easily accessible form expert descriptions, fully illustrated, of the latest and best productions of the engineer and manufacturer of every country ; the practice of Central Station men ; the work of the student ; the experience of the skilled artisan ; critical reviews of the best books on electrical subjects as published ; concise details of new patents ; and a succinct trade and financial survey indicating business possibilities and opportunities.

The special feature in the scheme of this Magazine is that the whole of the subject-matter is *sectionised* for ready reference, the reader being thus enabled to turn at once to that particular branch of electrical work with which he is most concerned, thus securing the maximum amount of valuable information and interesting reading matter in the least possible space—consistent with its importance—without having to wade through pages and pages of extraneous matter Each section of the Magazine has its special Associate Editor in the person of an acknowledged expert, and every line of the journal carries the impress of authority. The Magazine, in effect, presents the science, industry, commerce and finance of the whole field of electricity on entirely original lines.

With regard to the claim that this new production is required by the national trade exigencies, it is more than sufficiently apparent to all who are connected with electrical work that Great Britain is meeting with a competition which is as unfair as it is pernicious, and it is the intention of this Magazine, whilst preserving to itself an international character—which is essential—that the British electrical industries shall have a vigorous exponent of *British* trade rights, methods and work, which should carry conviction to the minds of those in high places, and render a service both in regard to the retention and expansion of home and foreign business, the keeping up of legitimate prices, and in respect to preference, where possible, for British manufacture. In this connection, however, a consistent and impartial policy will be followed. Where British work is wrong in principle or practice it will be fearlessly exposed, and Continental and American methods will be described and illustrated in a manner which cannot fail to be of the utmost value to all whose interests are bound up with electrical work in the United Kingdom.

It will be seen that *The Electrical Magazine* has a policy and a mission. In no sense is it, or will it be, a partisan journal. It will be run on a perfectly independent platform, and the proprietors feel assured that such a publication will have a greater utility and be more forceful in its effect than any electrical periodical hitherto existing.

As to its success, it is only necessary to say that such strong support has been received, both commercially and financially, from the electrical fraternity all over the country, that the establishment of the Magazine on a firm and enduring basis is practically assured. It has command, in its literary columns, of the leading writers on electrical subjects in both hemispheres, and the active assistance of the most progressive commercial men of the day. The paper, typography and engraving have been selected with the greatest care and discrimination. For the rest, its business organisation is of a character which will ensure the most effective services being rendered to its supporters, and nothing that money, enterprise, and talent can accomplish will be left undone to render *The Electrical Magazine* of maximum value to all engaged in electrical work the world over.

A SURVEY OF THE ADVANCE . IN THE ELECTRICAL INDUSTRY

During the Past Twenty Years.

BRIEF, though full of portent, is the history of the electrical industry. It has grown to its present enormous proportions with such amazing rapidity, that we find it hard to realise that, twenty years ago, there was no electrical industry, in this or any other country, in any sense analogous to that existing at the present time. The gigantic branch of modern engineering represented by the generation and transmission of electrical energy was then in its merest babyhood. It is true that electricity was receiving attention in its aspect as a motive power, but the general tone, at least in this country, regarding it was of a deprecative nature. "The subject," remarked the leading electrical organ of the time, "is hardly likely to make very rapid progress, as inland natural powers available for transmission are but limited in number," and thereafter proceeded to intimate that the service of electricity as a motive power, would depend on the utilisation of ocean tides!

The fact that such sentiments as these represented advanced electrical opinion so late as the year 1880, forms in itself a striking illustration of the tremendous strides that have been made since that time. In that year, too, we see what are described as "sensational cables"—the precursors, alas, of many more with less foundation—from the United States announcing the discovery by Mr. Edison, "quite by accident," of a "new electrical lamp." Swan also made a simultaneous discovery over here. Such was the herald in this country of the birth of the incandescent filament. That year also witnessed the illumination of the British Museum with the electric arc, which also threw an imperfect and fleeting radiance on the vistas of the Thames Embankment. These striking events were regarded with mingled pleasure and consternation; the latter chiefly concerning the Gas Companies whose apprehensive shareholders were magnanimously reassured by the *Telegraph Journal and Electrical Review*, which declared that "Gas has not been, nor is likely to be, superseded by electricity"; a somewhat hardy prediction, but one not unjustified by events.

Twenty years ago, electrical engineering, as we now understand the profession, did not exist. Electrical engineers there were; at least those who called themselves such; but they were chiefly concerned with telegraph and cable transmission. The mechanical electrician, who has since attained so important a position in the world of industry, was then on a level with his art, then beginning to struggle into existence under a multitude of adverse circumstances.

It will be recognised that the English electrical industry entered into its active career under most discouraging auspices. To the ordinary observer, it must be difficult to understand why so all-important a development of the mechanical arts should have been so tardy in arriving at any degree of maturity; why we should have allowed ourselves, in the very home of engineering science, for a period at least, to be out-stripped by foreigners. A short review of contemporary circumstances will throw an interesting light upon this question.

This country has been wedded to steam. Steam power was the gift of England to the whole world, and in their position as pioneers of steam, English engineers have remained proud and pre-eminent. The study of electricity gave quite a new trend to advancement in the mechanical arts, and one to which our engineers were most reluctant to devote attention. Electrical work was practically confined to the professors of abstract science, who found no co-operation with the manufacturing capitalist possible. He might demonstrate the possibilities of his dynamo to holiday audiences at the scientific institutions; but the "practical" engineer shook his head over his discourses, and could not be persuaded to regard his models in any other light than that of mere toys.

Yet, in the essentials of the electrical industry, this country had no reason to fear comparison with foreign rivals. Until it was brought into direct conflict with steam, we were as far advanced, and even ahead of other countries in electricity. In the evolution and development of telegraphy we showed the way to civilization ; even the present day wireless telegraphy was completely anticipated by Lindsay. In theory, our professors could be taught nothing from the countries from which we have been obliged to learn such a great deal since. The fatal bar was the lack of interest, of co-operation between science and its application. Our engineers could see nothing in electricity. In fact, they did not want it. The requirements of the world, they considered, were amply satisfied by the power they had brought to such an admirable state of perfection, and their attitude to the new force was compounded of indifference and hostility.

The Englishman, compared with the German or American, has a horror of experiment. His legislation is governed by precedent, and he has gradually introduced the principle into his manufacturing and business affairs. Because a certain thing has been done in a certain way a certain length of time, a kind of sanctity is conferred upon the operation which appeals irresistibly to the mind of an Englishman to continue to do it that way and no other. To the American, the reasoning has an opposite effect, to which is mainly attributable the perennial crop of more or less startling innovations produced by that country. The reluctance of Englishmen to get out of the beaten track has become proverbial ; and in the case of electrical development, it is painfully illustrated by the absence of English names from the roll of invention in this direction. Most of the names associated with electrical progress are not of British origin. The English engineer has taken a standpoint as a mere observer outside the field. He has treated electricity as a Cinderella, compared with steam, her lofty sister, and it is only of late years that the transformation has been effected before his eyes, and electricity, the rebuffed and despised, has taken to herself the attributes of power and grandeur which are her rightful due.

The consequences, however, of this mistaken attitude are being very rapidly repaired. Our engineers are showing a progress of a consistent and emphatic character evident everywhere. Electrical engineering, first introduced as a "department" of our great engineering establishments, is now rapidly becoming a dominant feature among them, and to-day it cannot be said that in electrical practice we are behind that of either the United States or the Continent. In an industry so diversified and so broad, all have something to learn from each other ; and in this respect England has as much to offer as to receive.

II.

The theoretical efficiency of the dynamo is so closely approached in practice that it is vain to look forward to any substantial improvement in this means of generating electrical energy. The minds of advanced electricians have been occupied, therefore, in another direction ; and they have sought to find what may be termed a "short cut" to the generation of electrical energy direct from carbon instead of incurring the appalling waste involved in the steam boiler and heat engine. Things, however, are possible in science which are impossible in practice ; and so far, the direct conversion of the calorific energy of coal into electrical power has evaded solution as a commercial practicability. A host of experimenters and patentees, from Dr. Borchers to Hugo Jones, have laboured at this problem, which, in spite of all their researches, remains, sphinx like, defying solution. It is true that coal can be, and has been, transformed into electrical energy by utilising the mineral as one of the elements of a battery. But like the energy of the tides, the primary economy of whose utilisation is consumed by works and gearing, the expense of accessories has more than swallowed up the prospective saving of the coal battery. The problem, however, remains one of the most interesting and important that can be presented to the mind of the electrical scientist, in that its solution would effect one of the most prodigious economical revolutions the world as ever seen. We have however, learned from experience, that evolution is always gradual in its progress, whether concerned with nature or the handiwork of man. No great sudden discovery in the arts and sciences has ever yet shaken the world. Science works in slow beginnings; her path is obscure and progress gradual, while the approaching consummation looms in sight long before the end is reached.

It is more than twenty years since the discoveries of Faure and Planté, by which it was imagined that electricity could be stored, like steam in a boiler, or water in a tank, gave rise to the most extravagant expectations. At the close of nearly a quarter of a century since the date of these discoveries, we are presented with that "triumph of American invention" the Edison cell, the result of much tedious labour. Though a model of mechanical design and striking a new note in accumulator construction, it has yet to surpass its lead rival in electrical efficiency. The storage battery is indeed one of the most mortifying and perplexing subjects on which the electrician can bestow his attention. How much could be made of the secondary battery, providing only certain small things could be done? And how little really has been effected since the date of its inception! As it is, the storage cell has been responsible for more lost time and more wasted capital than almost any other department of applied electricity. Invaluable as it is, how much more valuable it might become, providing only some reasonable compromise could be effected between weight and efficiency? But our hopes have grown modest since those days when it was believed the time was approaching when the hulls of sea-going vessels were to be one vast electric battery; when ships would derive their power from the oceans they sailed, with sea-water for an electrolyte! All these fond anticipations have disappeared; and we see that electricity, though mysterious as ever, is no wayward power; that it has its limitations, and obstinately refuses to give one pennyworth more power than the potential energy with which it is supplied. Perhaps the greatest progress made in generating electrical energy is represented by dry cells, which have attained an amazing degree of perfection.

Progress in electric lighting, has not, on the whole, been very marked since the origination of the filament lamp. Few recognise what is the almost prodigy of invention represented by the electrical incandescent illuminant, the real origin of which, in spite of the well-known names associated with it, is obscure. The Nernst electrolytic lamp, brought, after a number of specific failures to a brilliant commercial success by the Allgemeine Elektricitaat Gesellschaft, is the most noteworthy contribution to electrical illumination of late years, the vacuum tubes of Moore and others, so widely advertised for their illuminating efficiency, attaining little real progress, and none that entitles them to remark as a commercial factor. The efficiency of the most widely adopted electrical illuminant we have, the incandescent lamp, leaves much to be desired, and there is ample room for the further development of electricity for lighting purposes. Heat with light means waste; but it is probable that in time the *ultima thule* in this direction will be attained, and that a cold light such as that proceeding from the glow-worm, will represent the degree of efficiency which theory teaches us can be reached by the proper means.

III.

THOUGH the name of Moissan must always remain associated with the evolution and perfecting of the electric furnace, the home of electro-chemics has been established in Germany. In that country were most readily found the enterprise and capital required for the development, on a large scale, of this great branch of the electrical industry. In electro-chemics this country unfavourably compares with both the Continent and the United States, for in this sphere we appear to have shown hardly any originative faculty whatever.

We carry on, it is true, the manufacture of a variety of materials which are produced through the agency of the electric current; but, with comparatively few exceptions, the processes employed have been exotic from this country, and the patents which controlled them registered in Berlin or Washington.

Perhaps the most noteworthy product of the chemical furnace is the mineral, carbide of calcium, extensively used for the production of acetylene gas. This carbide was discovered almost simultaneously by Moissan and Willson. Moissan, a distinguished man of science, disdained to make any pecuniary profit from his discovery, the details of which he published without delay in the *Comptes Rendus.* Willson, however, protected his invention by a network of patents, the benefit of which he made over to an English company, who entered on the production of carbide of calcium, enjoying what they deemed a monopoly under their protection. The Willson patents, on being tested in the Law Courts, were declared invalid, mainly because of "prior publication" on the part of Moissan, and the production of carbide of calcium, so far as this country is concerned, is a free manufacture. The disinterested scientist, we see, has the power, on occasion, of enriching the whole world in a manner totally unapproachable by any other form of benefaction.

In the electrolytic production of aluminium, it was an American also, who first carried into commercial practice the researches begun by Wöhler, who was, undoubtedly, the primary means of giving the world a new metal possessed of many valuable qualities. And here, too, the English company, which licensed the American patents and erected an imaginary monopoly on their foundation, have seen these patents, together with the valuable consideration paid for them, disappear in thin air in consequence of the resurrection and recognition of anterior patents in the United States for the same end.

The absence of originative faculty in this important field in this country is to be deplored.

Speaking generally, when a nation, which has been accustomed to lead in the van of manufactures, has to buy in ever-increasing quantities the products of other countries which could, and should, be made at home, that nation is called upon for strict self-examination to find and, if possible, remove those causes which are exercising an effect so prejudicial to its advancement. But it is a fact, apart from other considerations, that when we look around we are struck with a certain lack of initiative, which is revealed in more than one branch of industry. Some manufacturers appear to have lost sight of the fact that progress is the law of the universe. We are far from saying that this attitude is generally applicable. A great many of our captains of industry are showing the way with a vigour and enterprise worthy of the best traditions of the race. These men, combining pushfulness with careful business management, will forge ahead, to their material benefit and that of the country, unless held back by unfair trade restrictions.

We may, indeed, quote here a "sentiment"—which, though but a sentiment, embodies an eternal truth—adopted as a kind of motto for their works by one of the most able and enterprising firms of engineers in this country: "*Whoever is satisfied with what he does, has reached his culminating point; he will progress no more. Man's destiny is not to be dissatisfied, but forever un-satisfied.*"

In the field of electric traction, it is a sardonic commentary on our position, that, whereas we sent into every part of the world English engineers and English workmen, pioneers of railway progress, we have patiently permitted Americans to come 3,000 miles to construct our electric tramways, and develop, on a larger scale than we seemed capable of, many important electric railways. As a matter of fact our American cousins have re-imported here what they originally took from us. The Germans, in their turn, with that thoroughness which ever marks their labours, have grappled in a practical manner with the problem of electrifying main railway lines, and whatever solutions be yet forthcoming, they will without doubt have been materially forwarded by the experiments at Zossen.

Whilst we are far from agreement with the exaggerated strictures of some extremist organs of the general press, we believe it is generally recognised by economical publicists that we are suffering from a lack of originative power, which places us at a considerable disadvantage with our two great rival nations. It is true our wants are so easily satisfied under our existing fiscal system, that this may have some influence in promoting the sort of intellectual indolence so prevalent among many of us at the present day; and if it is true that "necessity is the mother of invention," our great national prosperity may be accountable for the dearth of English imaginative faculty so prominent in the roll of discoveries in the arts and sciences during the past twenty years.

But, so far as the electrical industry is concerned, it is impossible to disregard the repressive effect which ill-considered legislation has exercised on its development and progress. The abuse of Provisional Orders, by Municipal Authorities, has certainly been carried to extreme lengths, and has brought a most damaging influence to bear upon private enterprise. Legislation, however regrettable its effects may be, cannot be held wholly accountable for the delay which has taken place in this country in the development of electricity. There are other causes, the chief of which we have specified. It is satisfactory to note, however, that the elements which largely militated against electrical advance are disappearing, even if not altogether removed. The British manufacturer is reluctant to change; but when he comes to a resolution, he carries out his purpose with a vigour and determination which usually more than restores the balance of lost time against him.

IV.

THE *personell* of the electrical industry now embraces, without exception, all the great firms of English mechanical engineers. Electrical engineering, indeed, is now so universal, that it threatens to swallow up the so-called mechanical engineer, and any distinction between him and the electrical engineer is growing so slender that it will one day disappear. An amalgamation, therefore, of the Institutions of Mechanical and Electrical Engineers would appear to be a logical consequence of the trend of affairs; and this, should it be effected, could not fail to be of benefit to both of the sections, and to add a further weight and dignity to the profession as a whole.

In casting back twenty years, it is curious to note how recent are most of the well-known names in electrical engineering. In 1880 two or three only were prominent. Johnson and Phillips owed the pre-eminence they enjoyed then, and have maintained ever since, to the fact that they were the main suppliers of the telegraph and cable systems which then represented the bulk of electrical manufactures. The "Gramme machine for the transmission of Motive Power," was being timidly introduced to an irresponsive public, and of the lonely pioneers of electric power, were Edward Paterson, whose name is still before the public in the form of Paterson and Cooper, and Siemens Bros., who were engaged in the effort to introduce their "Patent Dynamo-Electric Machine." To Messrs. Robey and Co. must be attributed the enterprise of first making, and then actively pushing, a "Patent Electric Light Engine," whilst the India Rubber, Gutta Percha, and Telegraph Works Company, stood then in all the dignity of the vast corporation which they continue at the present time.

But when electricity was once recognised at something approaching its real importance in the industrial arts, the accessions to its ranks were fast and furious. The title of "electrical engineer" became ludicrously abused, and rendered the establishment of an official organization imperative. To this day, however, the ranks of electrical engineers have some singular exponents of the profession. Some combine electrical engineering with plumbing; whilst there lies before us now the announcement of a firm of "electrical engineers" which, while expressing its readiness to undertake any description of electrical installation, reminds the public they can have their spoons electro-plated at the establishment "while they wait." All such weeds as these, however, are bound to shoot up for a fleeting existence, in a new and fertile ground; and seeing that a qualified electrical engineer must of necessity be, in addition, a mechanical engineer, it will be seen the dignity of the profession requires no safeguard beyond that which it receives at present.

And, as regards the rising generation of electricians, we are beginning to depend less and less upon the products of electrical schools and colleges. The true education of the electrician is his work in the manufactory itself; for the kind of knowledge with which he has been supplied in past days, was usually the despair of his employers when he entered upon a practical career. We are far from underrating that scientific education which is the indispensable foundation for the accomplished engineer. But it may be said of the majority of our technical institutions, that less theory and more practice would be a useful variation to the curricula even now in vogue.

The lack of State encouragement has had its share in retarding the scientific progress of the country. In view of the magnificent scale of the state-aided technical institutions of Germany and the United States, the pitiful appropriation extorted with such difficulty for the foundation of a Laboratory of Physical Research appears mean in the extreme. For years the Government obstinately refused to see the necessity of such an establishment at all; and it was only when representations of such scope and weight were made, that it became impossible to disregard them, that the present feeble imitation of the German Reichsensault was erected. We might surely learn from the example of our neighbour, seeing the incalculable national benefit the great scientific establishment in Berlin has been to Germany, that economy, in some cases, may prove the worst form of extravagance.

The writer may fittingly conclude this brief and imperfect review with one or two observations on the work and destiny of *The Electrical Magazine*.

It would be unbecoming to advert here, except in the most general terms, to the great and representative body of support accorded to the reception of a periodical, which has for its chief object the co-ordinating and placing in a lucid and accessible form, the vast mass of electrical knowledge that is accumulating month by month throughout the world. Scientific authorities, as well as men of affairs, cordially welcomed the advent of a magazine which should present month by month, in a concise yet comprehensive form, the electrical information which is now scattered through a number of miscellaneous publications, which, even if accessible to, would be a hopeless task for the perusal of, the busy man. *The Electrical Magazine*, however, will be something considerably more than a collation of the cream of electrical thought and electric progress. It will aspire to worthily represent and justify British electrical engineering to the world. What British engineers have done in steam engineering, they are able to do in electrical engineering. Pre-eminent in one, they can become pre-eminent in the other. In broad affairs, capacity is the test of advancement; and capacity on the part of British engineers has never been brought into question.

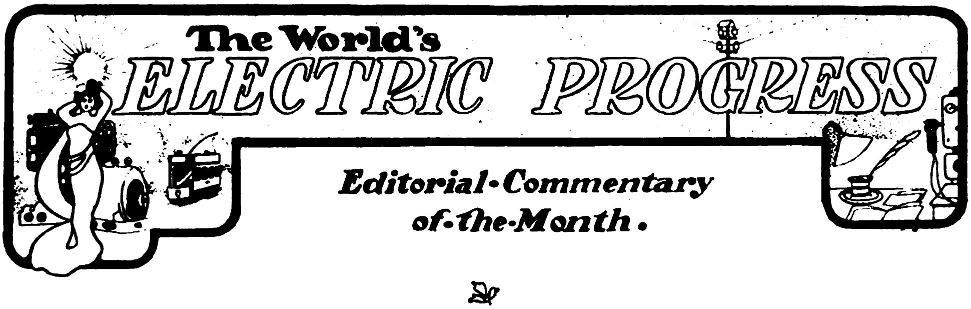
In all the wild criticism with which he has been assailed, no one has ever ventured to impugn the supreme ability of the British engineer. The charge against him has never been more than undue conservatism; a want of agility, as it were, wherewith to adapt himself to altered circumstances. There may be a certain amount of truth in that, but this we know, that great changes are not, in the nature of things, made hurriedly. Movement in great bodies, in the beginning, is always slow. But, though slow, its progress is irresistible.

The Electrical Magazine then, acclaims the advance of British electrical engineering, and awaits with confidence the time when the glorious achievements of our engineers in the past shall be reflected with a double lustre on the coming glories of the future.

❧ ❧ ❧

"Not by a sloth supine did our ancestors
Or crooked courses, work out the liberties
Sacred of Britain, and establish
Laws of equality for the nations.
Spurning an easy existence, their fatherland
Mighty they made, Heaven's favour regarding them;
And life once o'er, of all their labours
Won for their meed a reward eternal.

Good work with praise grown great, turns to mockery
Envious time; but not if there cease to be
Golden performance, stands our fathers'
Example adorned with a praise befitting.
Rather the labour that daily more glorious
Shines, in things irksome great, bequeathing
The fame of British work never dying
To generations of children's children."



The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

* * *

This section will consist of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They will be mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

* * *

Golden Opinions. On the eve of publication we may be pardoned for referring to the highly eulogistic manner in which the press of the United Kingdom has welcomed the advent of *The Electrical Magazine*. A unanimous concensus of opinion has been expressed as to the merits and utility of a journal, the conception, plan, and treatment of which, a leading newspaper declares to be absolutely unique.

* * *

Our Sections. We offer no apology for prefacing our sections, in this the initial number of *The Electrical Magazine*, with introductory addresses which pass in review the chief events in the electrical world during 1903. We have naturally, in so doing, been compelled to exclude other highly interesting matter, but in the succeeding issues the sections will conform to the standard laid down, for a comprehensive record in each particular branch of electrical work and progress.

* * *

Municipalities and Wiring Contractors. The Marylebone Boro' Council's Electric Lighting Bill has now been published, under which it is sought to raise the sum of £1,188,144 for a municipal electric supply. The consent of ratepayers will have to be obtained, but is is safe to presume the Bill will receive their sanction. There is one very objectionable clause in the Bill, which we hope will not be allowed to pass. This deals with wiring-fittings and motor-wirings. Concerning the latter there is little to be said from our point of view; but the prospect of the municipalities undertaking house-wiring, raises an important question. The passage of the clause would enable the Borough Council not only to do its own wiring in competition with wiring contractors, but to prescribe to these contractors rules and conditions as to the manner in which they should carry out their work. It is hardly to be anticipated that the clause in the Bill will emerge without having been hotly contested, and it is sincerely to be trusted the opposition will be successful.

* * *

A New Source for Copper. Manufacturers of electrical conductors will be pleased to learn of the opening up of a new and—it is trusted—a permanent source of supply of copper. The first shipment of copper ore from the East African mines has recently been made from the port of Beira, consisting of 19,000 bags, weighing over 1,000 tons, of high grade ore from the Edmundian copper mine, which, though lying in Portuguese territory, is controlled entirely by English capital and

English management. This shipment is expected to be followed by others from the same mine to the account of the Consolidated African Copper Trust, Ltd., about every two months; in which case, the new supplies will have an appreciable influence upon the European market. It is well known that copper mining is being actively pursued in Rhodesia, where there are properties of immense richness· so much so indeed, that the term "mining" applied to the exploration of the properties is a misnomer, the ore having simply to be quarried out like stone.

◆

On Fires. The increasing employment of electricity for theatre lighting is perhaps accountable for the readiness of the daily press to make it the scapegoat for such disasters as the recent fire at the Iroquois Theatre, Chicago. The outbreak at Sandringham was another occasion on which statements were scattered broadcast, tracing the origin of the conflagration to the fusion of certain wires in the electric light installation. In the first case the source of the catastrophe has been utterly obliterated, so that the refutation of any wild statements is directly impossible, but the presence of calcium lights on the stage should receive full consideration, as explosions, in no way akin to electrical phenomena, are possible with this apparatus. While admitting that electrical energy, if improperly employed, is fraught with danger, in the temporary lighting common to spectacular stage effects, we must protest against the statements of our daily contemporaries, too often based on ignorance of the physical potentialities of electricity under such circumstances. The Sandringham incident afforded irrefutable evidence of the hollowness of the reports attributing the occurrence to an electrical source and we feel that in many similar cases, with careful inspection, equally assuring evidence would be forthcoming in support of the comparative safety of electricity for lighting purposes.

◆

Important to Student Readers. Those interested in the technical education of this country will be pleased to learn that we have completed arrangements which will allow *The Electrical Magazine* to be at the disposal of electrical students on special terms throughout this country. These arrangements do not imply any profit of a pecuniary nature—strictly speaking, the reverse will be the case. But those associated with the magazine feel that its educative influences should be extended over the widest measure, and willingly make some slight financial sacrifice in order to promote, as far as may be in their power, the knowledge and efficiency of those on whom depends to a great degree the engineering future of the industry. The co-operation of professors, lecturers, and masters of technical institutions is anticipated by us in our scheme, but, in any event, we invite their assistance and enquiries on behalf of the students under their charge, and whom they can materially advantage by acting as media on our behalf. While directly appealing to students in the section set apart for the purpose, the magazine, by reason of its broad outlook upon general and specific electrical affairs, will have a value far and away above any publication exclusively devoted to technical institutions, and in this respect we confidently appeal to teacher and student alike, as presenting each with a ground of common thought.

◆

Dublin's Electrical Affairs. A peculiar situation has arisen in the affairs of the Electric Light Committee of the Dublin City Council. That body applied to the Local Government Board for permission to raise a loan for lighting extensions, and were met with the unexpected response that the amount they asked for was too small for the purpose, and that they had better apply for some more. The Local Government Board even went so far as to point out the sum actually requisite, in addition to the amount of application, and suggested an increase of £4,300. It will occur to everyone, in view of the Local Government Board's recommendations—the soundness of which does not appear to be disputed—that if a public body can be found to act as technical advisers in this benevolent way, what is the use of employing a Consulting Engineer? How thoroughly the Local Government Board have gone into the

Dublin scheme may be realised by one quotation: "He" (a member of Electric Light Committee) "feared he must agree with the Local Government Board, that according to Mr. Hammond's (the Engineer's) own estimates and evidence at the original enquiry, there should have been a saving of £6,000 by reason of dispensing with the step-up transformers, and generating by a cheaper method." This strict Government supervision of municipal schemes is a public benefit of a high order, and consistent with the admirable work our Local Government Board has accomplished in other directions.

* * *

Trade and Fiscal Policy.

SEEING that electrical engineering comprises many industries of the highest importance to the country, it is manifestly appropriate for us to devote some space to an examination of the circumstances of these with relation to the change proposed in our Fiscal Policy. In our article, "The Fiscal Problem," introducing the Trade and Commerce section, the author has, we venture to say, handled this matter in a very reasonable spirit, and in moderate terms; and, with the assistance of some well grouped statistics, makes out a case which we think well worthy of the consideration of the opponents of Mr. Chamberlain's policy. The author shows that the electrical industry, in common with most others of this country, finds our foreign markets less and less open to us, whilst our export trade with our Colonies and other British possessions is mounting rapidly and steadily. That is to say, purely British trade is more valuable to us, in its accumulative aspect, than the trade of the entire rest of the world, which shows a tendency to diminish as rapidly as that of our possessions to increase. The question as to why we should continue to open a free market to rivals who close their own against us, is invested with additional emphasis when we consider that England is the producing centre to which the British Empire looks for its supply of manufactures. There can be no doubt that the "dumping" of products for which there is no use in the country of their origin upon our shores, must materially impair our manufacturing power as a nation. England in her present position might not unfairly be regarded as the scrap-heap of the manufacturing world, for it is notorious that the manufacturers of both United States and Germany look upon it as a convenient place on which to throw the undisposable part of their surplus production.

* * *

Foreign Goods as British.

IN a fair consideration of the balance of our Foreign and Colonial trade, there is one very important fact to be borne in mind. Whilst we congratulate ourselves on the steady increase in our trade with our own people beyond the seas, we are at present ignorant to a large degree what proportion of the goods we supply them are really of our own manufacture. It is common knowledge that consignments made to the Colonies from London, consisting partly of British and partly of re-exported Continental goods, are classed as of "British Origin," leaving the rest to statistics which to some degree are bound to be fallacious. It is true the Preference recently granted to England by South Africa, our first trade customer, will have the effect of sifting out Continental from British goods in these shipments, for the Certificate of Origin prescribed is stringent; but thus far, it is too early to judge from the returns what this proportion may have been, so far as that country is concerned. In the meantime, this, as we state elsewhere, is essentially a period for deliberation and the interchange of ideas, in which we shall be pleased to take our share.

* * *

The Third Rail.

MR. GEORGE WESTINGHOUSE, who certainly is not distinguished by any undue diffidence in his utterances, denounces the third rail, and pins himself to the overhead system for electric railway traction. It requires some courage to advocate an overhead wire in view of the enormous prejudice existing against this manner of transmitting electric energy. Yet Mr. Westinghouse presents a logical case. Three or four years ago he effected a mild sensation amongst gas engineers by his bold suggestion that the gas companies should stop the supply of gas for lighting purposes and devote it instead (by the employment of Westinghouse gas engines) to the generation of electricity. The proposition was not received with much enthusiasm, although coupled with the undeniable inducement that the existing gas mains could be used for electrical distribution purposes. The Westinghouse plan, however, has been realised in other directions, and it is possible the third rail may yet be superseded to a large extent by the whilom discarded overhead wire. "It may be heresy," says Mr. Westinghouse, "to advocate the use of overhead wire, but I venture to predict that there will be a complete revulsion of feeling on this point. When I speak of an overhead wire, I do not mean the slight construction which has prevailed, and the breaking down of which has occasioned trouble, but a substantial engineering arrangement, so erected that it would, in fact, not be an offence to the eye." One of the chief arguments against the employment of the third rail in any highly developed railway system is, of course, that any form of third rail is impossible at important junctions and terminals. Another point is, that with any form of contact shoe as at present employed, it is impossible to cover—or, in other words, to protect—the third rail, and there must always be the danger of a short circuit in case of derailment or other accidents.

* * *

The Bristol Disaster.

THE recent disaster at the Temple Back station of the Bristol Corporation must impress electrical engineers in at least three ways. Firstly, with the weaknesses of high tension switchgear, no matter how good; secondly, with the incredibly short space of time in which supply can be renewed, even when the "heart of the system" has been literally destroyed; and thirdly, with the unanimous support accorded an engineer in distress, by his staff, both present and past, his committee, engineering *confrères* and neighbour suppliers of electrical energy. Our sympathies are extended to Mr. Faraday Proctor in his misfortune, coming as it did at "top load" time, when anxiety at the station is of the keenest nature. Only station engineers accustomed to high tension plant know how to stick to their duty under such trying circumstances, and we can assure our readers from personal experience that no small courage is needed to face the consequences of switchboard arcs fed by thousands of horse-power. History finds room for instances of the hasty retreat of the staff and the abandonment of the plant to its fate, under conditions analogous to those of the Bristol accident, but happily such records are not to be found in the annals of British central station practice. The destruction of the switchgear is, we understand, attributable to the failure of a fuse to act, the resulting arc quickly assuming appalling proportions from the 3,000 K.W. of plant feeding it. The accident is the first of its kind on a cellular board, though we venture to think that the subsequent fire was not as serious as would have been the case on a gear with rubber covered connections behind marble or slate panels. We have received an exhaustive report on the fire from Mr. H. W. Clothier, Manchester, which advances probable reasons for the occurrence and details its effects, giving in conclusion some measures for the prevention of such accidents. Wooden platforms and rubber mats, and the exposed insulation of the incoming cables, are, in his opinion, responsible for the actual spread of the fire beyond the gear. A number of interesting diagrams accompany the report, and if space permits we shall comment on these in our next issue.

* * *

Standard Nomenclature for D.C. Machines. Opinions Wanted.

IN these days, when standardisation is in the air, it would be well if the various makers of direct-current dynamos and motors could agree upon a uniform system of designating the various types of machines placed upon the market.

We refer particularly to the frames carrying, and in varying measure protecting, the essential parts of such machines. At present it happens that machines essentially designed on similar lines are described by the different makers in terms which convey no definite or intelligible clue to the characteristic form of construction. It may be that some firms attach importance to the use of designations peculiar to themselves, but such a consideration does not appear to carry any weight with buyers, and the true interest of manufacturers would be better served by the formulation of standard nomenclature for the various types of machines.

Practically all the direct-current machines now made can be placed within one of the following categories:—

(1) Open type, as exemplified by the ordinary dynamo.

(2) Protected type, in which the casing forms part of the magnetic circuit and protects the whole of the working parts with the exception of the driving pulley, and in which the end covers are provided with apertures, permitting free circulation of air.

(3) Semi-enclosed type, the casing of which is provided with end covers having wire gauze screens fitted in the apertures.

(4) Enclosed type, in which the end covers are solid and the casing is made air-tight.

The most suitable terms for application to these types could be settled without much difficulty if the leading manufacturers had an opportunity for the interchange of ideas. With this object in view we bring the matter before the notice of our readers, and hope that some expression of their opinions may be forthcoming.

William Gilbert.

At the celebration of the Tercentenary of "Gilbert of Colchester," Dr. Sylvanus Thompson appropriately described Dr. William Gilbert as "the Father of Electrical Science." Colchester may well feel proud of that distinguished man, and of the painting recently presented to the town by the Institution of Electrical Engineers. Electricians must also feel grateful to Mr. Ackland Hunt, the painter of the picture, for the detailed study given to his work, the execution of which occupied many years, and, as Dr. Sylvanus Thompson said, had been to the artist a labour of love.

It would be difficult to over-estimate the debt of the profession to Gilbert, for, as we are told, "there were statesmen before Cecil, naval heroes before Blake, explorers before Raleigh, poets before Shakespeare, and philosophers before Bacon, but before Gilbert there was no electrician." A busy physician, taking a prominent part in the profession of medicine, he nevertheless found time for scientific research, and devoted large sums of money to the institution of experiments which enabled him to lay the foundations of the science of terrestrial magnetism.

Gilbert avoided the error, not uncommon even in the present day, of publishing his theories before he had thoroughly verified them by observation, and his great work "De Magnete" fully deserves the commendation bestowed upon it years ago by Dr. Whewell, the great Master of Trinity, that it contained all the fundamental facts of the science so fully that little could be added to them at that time. Even after the advances made by science since this saying, it is still true as regards essential principles. The assembly of distinguished men who met last month to do honour to the memory of an illustrious man of science is sufficient fulfilment of Dryden's prophecy "Gilbert shall live till loadstones cease to draw."

The Edison Accumulator.

The interest taken in Mr. Hibbert's recent paper on the above subject, read before The Institution of Electrical Engineers, might have been even more acute had not particulars of his report leaked out prematurely in America, and many of his data and curves been already published in the technical journals. But as it was, he had a most attentive audience, and with good reason, for the occasion of the first formal publication of practical tests of a new type of storage cell, distinctly different from anything at present in use, and backed by the name of one of the world's most successful inventors, might easily prove to be a milestone by the wayside of electrical progress. So accustomed are we to associate the storage of electrical energy with the limitations of the lead accumulator that we forget these present limits rest upon no impassable laws, and that many new possibilities would appear were something available more nearly corresponding in its capabilities to a water reservoir or a gasometer.

A storage battery is wanted combining moderate first cost with high efficiency and trifling depreciation. The lead cell might fulfil the first two conditions, but has failed so far at the third. The Edison alkaline cell is reputed to be expensive, but it should be produced cheaply when its manufacture is finally standarized and carried out on a large scale. Its average energy efficiency of about 50 % dispels for the moment our dreams of the widely extended application of accumulators in heavy electrical engineering, for the cost of power would have indeed to be low to justify the waste of half of it in storage.

The fitness of a storage battery for use in automobiles and certain other directions must be judged by a different standard to that just mentioned. Prime cost and efficiency are now comparatively unimportant, and their place is taken by output relatively to weight and volume; but, as before, rate of depreciation is of vital consequence. Nor can a low price be off-set against short life, by showing that the more frequent renewals may be paid for with the extra capital otherwise expended on a higher priced battery of greater durability. A battery of light-weight lead cells in heavy work in an auto-car may require to be overhauled within a month of first setting up, and every month following for, perhaps three, perhaps six months, during the whole of which time the output and consequent mileage limit of the vehicle will be steadily decreasing until a new set of positives is put in. The same programme is then repeated, but under worse conditions, because the negatives are probably beginning to show signs of wear and proving unequal to the demands made upon them. In addition, it frequently happens that individual cells short-circuit or fail in other ways, and the whole battery may break down or become prematurely worn out by unavoidable or accidental bad usage. Even should the cost of labour and material involved in this constant supervision and renewal be strictly reasonable, most people would willingly incur a considerable additional expenditure, if by so doing they could be rid of the feeling of unreliability and uncertainty now so common, except in carefully organised garages where a large number of vehicles is systematically dealt with.

It is in these respects that the new Edison cell promises such a marked pre-eminence, and Mr. Hibbert very wisely made this point the key-note of his paper. The permanence of the cell's performance and its flexibility in responding to the heaviest demands, are both emphasized, even in tests of short duration, but it is regrettable the makers of the cell did not furnish the authors of the recent reports with details of its behaviour over a more extended period. Of course it could not have carried quite the same weight as their own personal experiences, yet would, under the circumstances, have been accepted as a thoroughly responsible statement. Referring to Mr. Kennelly's paper of May, 1901, on the Edison cell, we find that the design and construction of the electrodes were then identically the same as now, and from the claims made, this cell must also have exhibited similar if not slightly superior excellencies. We may be sure that the two-and-a-half years since elapsed have been periods of strenuous endeavour directed to the solution of some very definite problems and accompanied by a mass of tests and data which cannot fail to give clear indications as to the ultimate "death" of the cell, and whether the depreciation is slow and gradual or sudden and complete. It is not unreasonable to surmise that the active materials have proved uncertain in their behaviour and difficult to control, but perhaps when the adjourned discussion takes place, some light will be thrown on these and other important points not touched or in the paper.

◆

On Radium.*

PROBABLY the most important result of the new discoveries in connection with radio-elements, of which radium is the most remarkable example, is the conclusion to which we are forced that a far larger amount of energy is associated with matter than is ever rendered free and drawn upon in the ordinary course of events. It is probable that the only difference between the radio-elements and the elements which are not radio-active, or at least the heavier examples of the latter, is that in the former this store of energy is being slowly dissipated, whereas in ordinary matter it remains untapped. An oft-quoted remark of Professor Rutherford, that there is enough energy in a gram of radium to raise 500 tons a mile high, applies probably not only to this excessively scarce element, but to other heavy elements as well. At any rate, it is difficult to escape the conclusion that the other radio-elements, uranium and thorium at least—and these can be obtained without difficulty by the ton—possess just as much, if not more, energy than is stored up in radium, but that in these cases it is being dissipated at a very much slower rate. In chemical change, of which the most commercially important examples, *viz.*, the conversion of carbon into carbon dioxide, and of hydrogen into water by the process of combustion, are also those in which weight for weight the greatest amount of energy is liberated by matter, we get as a maximum 4,000 gram-calories for each gram of matter employed. Thus the production of a gram of water from its elements gives sufficient heat to raise 4 kilograms of water one degree Centigrade. In radio-active change, for example, in the complete disintegration of radium into other elements, of which helium is one example, we get about a million times as much; that is to say, one gram of radium, during its complete life, would give out heat enough to raise several thousand *tons* of water one degree Centigrade. But for the case of radium we should have to wait a long time for the change to complete itself. It would probably be half finished in from 2,000 to 40,000 years. For the case of uranium this time would probably have to be increased a million-fold. Fortunately, however, there are other kinds of radio-active matter known which change faster. Thus the *radium emanation* has a short life and a merry one. It runs through its course and completely disintregrates in about a month. We are able to obtain it, thus late in the world's history, because it is being continually created in the break-up of the radium. The elaborate measurements of MM. Curie and Laborde, and of Professors Rutherford and Barnes, can be combined with results recently obtained by Sir William Ramsay and F. Soddy, to give a direct experimental proof that the energy liberated in radio-active change is a million-fold greater than is liberated by a similar quantity of matter in any other kind of change.

To the practical man this will appeal as a laboratory fact, and he will doubtless leave it to the chemist and physicist to settle the academic question as to whether the atom does or does not break up. The existence of this store of energy in matter is proved; to control it, to find the key which shall unlock it at will instead of at the grudging rate at which an economical Nature supplies it, is not an academical question. Its accomplishment would shake our social fabric to its foundations.

So the position at present is this. The property of radio-activity has revealed an unsuspected store of energy in matter, which in certain cases is being dissipated at a slow rate, and in other cases where it is being dissipated more rapidly the quantity is correspondingly smaller. It will be readily seen that one of these two alternatives must be true, if, as we believe, the process of dissipation has been going on unceasingly from the beginning of things. That uranium and thorium are still fairly plentiful elements is eloquent testimony of the extremely slow rate of the change in these cases. Indeed, to look at the matter from another standpoint, instead of our complaining at the grudging hand with which an economical Nature disburses the supply, we may feel thankful for the slow rate of dissipation in the case of uranium and thorium, thus preserving these elements to a time in the history of the world at which science has advanced far enough to unravel the secret and to aspire to tap the main supply for her own purposes. Let us hope that Nature has not so safeguarded her treasure-house that impious man may not one day prevail, and with a free hand scatter abroad in his own extravagant schemes these stores which have been so jealously husbanded in the past. What feats of engineering should we see accomplished!

---

[*] *In view of the universal interest in the mysterious emanations of radium, we are pleased to publish the above, written especially for The ELECTRICAL MAGAZINE, by Mr. F. Soddy, whose researches in this field have resulted in some valuable contributions to the present knowledge on the subject.*

SPECIAL ARTICLES

The articles in this section will be contributed by the best-known names in the realm of electrical science and the highest authorities in practical electricity the world over.

ON POLYPHASE GENERATORS.

By A. C. EBORALL, M.I.E.E.

In the 'following article the writer does not attempt to deal with the question of the electrical design of two and three-phase alternators, but merely deals with certain general matters relative to the development and construction of such machines, which may perhaps be of interest to the general reader.

Probably few engineers, not directly concerned with the designing of polyphase machinery, quite realize the amount of experience that is embodied in the design of the modern polyphase generator. A revolving magnet wheel, a pair of slip rings, and a stationary armature, consisting of a number of hand or former wound coils placed in holes or slots in a laminated core, constitute the machine which is the standard type in every country—a machine of the simplest possible character, and one capable of operating continuously with a minimum of attention in a manner which meets practically every requirement arising in practice. And, notwithstanding that such machines usually operate at really high pressures—10,000 volts is nowadays a standard value—probably no other class of (running) electrical machinery shares to such a great extent their comparative freedom from breakdown.

The admirable all-round performance of the modern polyphase generator is the result of successive improvements in the type and in the design effected by the different firms who have devoted themselves more particularly to long distance power transmission work during the last ten years. Foremost among these must be reckoned the Swiss firm of Brown, Boveri & Co., who have always led the way in this class of work, and in the design of polyphase machinery in general. With regard to polyphase generators, for instance, it is worthy of note that with this firm the revolving field type (each pole wound), has practically been a standard for large work from 1892-93 up to the present day; nearly all other makers who were also early in the field have, at one time or another, brought out, and attempted to standardize, either single exciting coil or inductor machines (particularly the latter), and have been eventually compelled to abandon them in favour of the revolving field type, by reason of their indifferent performance, particularly on inductive loads.

Probably the performance of the Lauffen three-phase machines (designed in 1890 and set to work in 1891 in connection with the famous power transmission to Frankfort),* influenced Mr. Brown's later designs very considerably, for, although the Oerlikon Company continued to make this type for some time after he left them, Mr. Brown completely abandoned it. His firm, which started operations in Baden at the end of 1891, practically standardized the revolving field generator from the beginning, as already stated.

---

* These machines were afterwards used for supplying energy to the town of Heilbronn. As far as the writer knows, the Lauffen machines and those at Hochfelden (designed about the same time) were the first commercial three-phase generators of any size; they are, of course, still in use.

The chief improvements which have been made in the design of polyphase generators since the days of these early machines are: (*a*) greatly improved pressure regulation on inductive loads; (*b*) better all-round mechanical design; (*c*) improved methods of armature insulation; and (*d*) the better utilization of materials, resulting in lighter and cheaper machines for the same output. Of these, perhaps the most striking improvement is the first mentioned. The early machines left much to be desired in this respect, full load pressure drops (at constant speed and excitation) of 30 per cent. and more being quite common for the case of slow speed generators loaded upon inductive loads. More than one firm has made exceedingly unpleasant experiences with such machines in the past—for instance, it has several times happened that, no matter how much excitation was given to particular generators, the proper pressure at full load could not be obtained. Nowadays, such cases are very rare, as the importance of reducing the magnetic leakage of the armature and field systems to a minimum, as well as keeping the armature reaction proper, within certain limits, is fully recognized. The modern revolving field generator has usually a full load pressure drop of 5-6 per cent. upon non-inductive loads, and 15-16 per cent. upon loads of 80 per cent. power-factor, and this degree of regulation meets the requirements of most cases. As a matter of fact, for the case of slow speed engine driven generators, better regulation than this is not desirable, on account of the requirements for parallel running; high speed plants, however, can be arranged to have a somewhat closer pressure regulation, where this is desirable, without an appreciable increase in the cost.

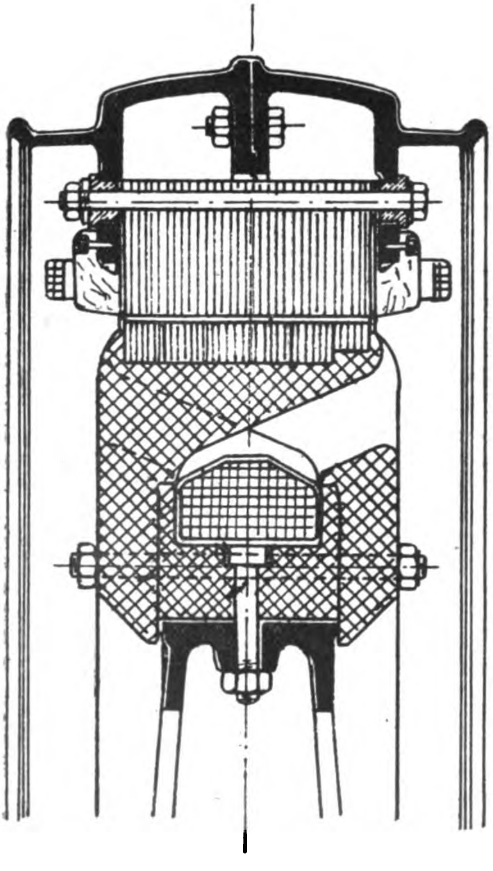


Fig. 1. Single (exciting) Coil Generator.
(Oerlikon Co.—obsolete).

Fig. 1 illustrates the "Lauffen" type of generator referred to above; its principal characteristics are the central single exciting coil, revolving with the magnet wheel; the special steel rims, carrying the pole-shoes, which project inwardly over the exciting coil, and the concentrated character of the armature winding, which usually consisted of coils or bars located in a single large hole or slot per pole per phase. In the light of modern experience it is easy to see at a glance the faults of such a design. On the one hand, the central exciting coil is a long way away from its work, and, owing to this, and to the small pitch of the pole-shoes, there is considerable magnetic leakage from pole to pole, even at no load, and with the smallest air-gap it is safe to work with; this magnetic leakage naturally increases enormously, directly the machine is loaded, particularly if the armature currents are lagging, and hence tending to de-magnetize the field system. On the other hand, the concentrated nature of the armature winding results in considerable armature leakage (self-induction), while the reaction proper of the armature has every chance of making itself felt, owing to the design of the field system. Such machines would be impossible at slow speeds, and could never be satisfactory at high speeds, from the point of view of pressure regulation alone; the type, however, had other defects, being noisy, and giving trouble with the field coil, as this, even when wound on a polygonal core, cannot be made perfectly satisfactory mechanically, unless a strip winding is employed, and the latter was unknown at the time.

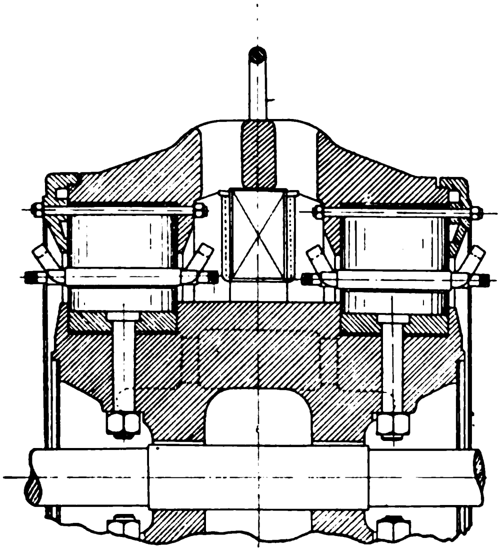


FIG. 2. INDUCTOR GENERATOR, WITH DOUBLE ARMATURE. *(Kolben & Co.—obsolete).*

The unsatisfactory performance of this class of generator was soon recognised, but the causes of the same do not appear to have been fully appreciated, for it gave place to a type of machine which is very nearly as bad, namely to inductor generators. These machines certainly enjoyed at one time a certain amount of popularity, on account of the fact that both armature and field windings are stationary, and hence no sliding contacts of any kind are necessary. Nearly every electrical firm abroad has built inductor generators at one time or another, and tried to make them a success—notably the Oerlikon Co., the A.E.G., the Schuckert Co., Ganz & Co., the Alioth Co., the Westinghouse Co., etc.—but the inherent defects of the type have led to its complete abandonment by everyone.

Figs. 2 and 3 represent the two patterns of inductor generator, the former representing the usual pattern, and the latter a pattern introduced originally by Mr. Brown, and used by him in a few special cases where the prime movers ran at abnormally high speeds. In the first pattern, the central stationary exciting coil energises a rotating steel wheel which is provided with polar extensions on each side, the two sets being in line with one another in the axial direction; all the polar extensions on one side have, of course, the same polarity, while all those on the other side have the opposite polarity. Each set of poles acts upon its own separate armature, the whole arrangement forming virtually two distinct alternators mounted on a common shaft; the two sets of windings are, however, connected in series, the output of the generator being consequently the sum of the outputs of its two component parts. The pattern shown in Fig. 3 differs radically in construction from this, although magnetically and electrically it is the same. Here, the two crowns of magnet poles act upon a common armature, this being rendered possible

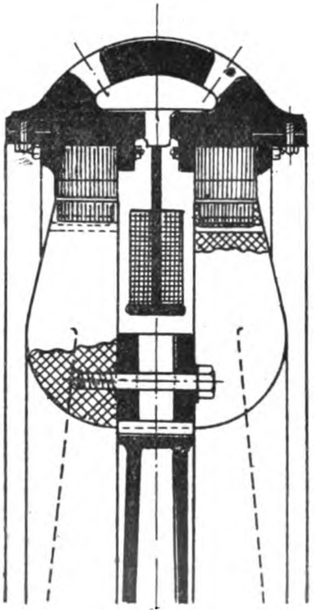


FIG. 3. INDUCTOR GENERATOR WITH SINGLE ARMATURE. *(Ganz & Co.—obsolete).*

by reason of the fact that the poles on one side of the wheel are "staggered" relatively to those on the other side, instead of being in line with them. For the case of the pattern shown in Fig. 2, when one side of an armature coil (on either armature) is opposite a pole, its other side is in the space between two poles, while with the pattern shown in Fig. 3, half one side of an armature coil is acted upon by a pole while the opposite half of the *other* side of the coil is being acted upon by the next pole. It is clear therefore that, in both patterns, half the copper on the armature is idle while the other half is active, and although this disadvantage is partly compensated for owing to the relatively high magnetic densities which are permissible with inductor generators, yet even under the most favourable conditions with regard to size and speed, such machines come out far heavier and more expensive than the corresponding revolving field generators.

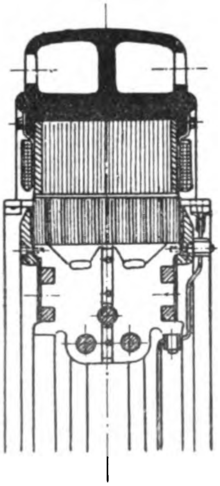


Fig. 4. Revolving Armature Generator. (*Westinghouse Co.—standard*).

The high magnetic densities at which inductor generators must of necessity operate, in order to be commercially feasible, are permissible on account of the non-reversal of the magnetic flux in the armature, which is, of course, the principal characteristic of the type. On account of the relatively large flux density in the air-gap, but also (and principally) on account of the magnetic requirements with regard to reducing the magnetic leakage of the field system as much as possible, small air-gaps are absolutely essential with these machines, and are at the bottom of the mechanical troubles not unusually met with in connection with the running of inductor generators after they have been in operation for some time.

A little consideration will show that with either type of inductor, there must be a good deal of magnetic leakage, and further, that this leakage is, for the most part, far more harmful than is the case, for instance, with the magnetic leakage of a revolving field system of standard design, each pole being provided with its own exciting coil. In the latter case that part of the field flux which does not get into the armature simply constitutes a loss, which is made up for by an increase in certain dimensions of the machine and in its excitation, but in the case of the inductor generator, a good deal of the leakage flux actually gets into the armature, but in the wrong place, that is to say, it cuts portions of the windings which should, at the time, be idle, and hence induces back pressures in the armature, which diminish the output, and impair the pressure regulation. The whole magnetic flux produced by the central exciting coil divides itself into three portions; the first, or useful flux, is that which enters the armature from the polar extensions, and the second is the leakage flux just referred to, which enters the armature from the body of the inductor, sides of the polar extensions, etc., by way of the space between the latter. The third is the flux not otherwise accounted for,

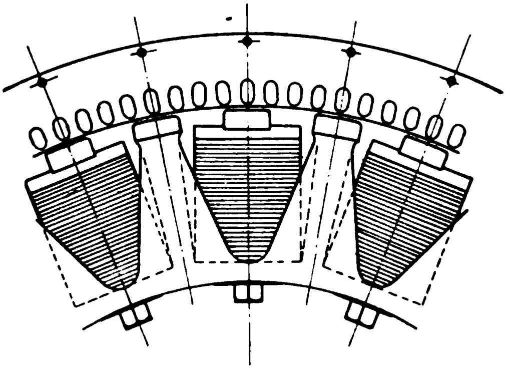


Fig. 5. Special Design of Field System, for Small Generators. (*Brown, Boveri & Co.—standard*).

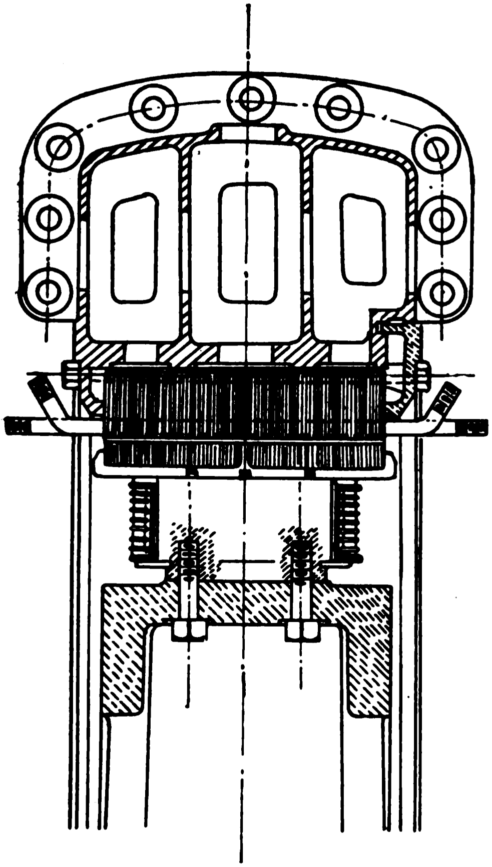


FIG. 6. FLYWHEEL GENERATOR, 3,000 K.W.
(Kolben & Co.—standard).

which does not get into the armature at all, this being for the most part the flux that leaks from the flanks of the inductor, and along the shaft to the pedestals, bedplate, armature casing, etc. Even with the most careful designing, these two leakage fluxes are very considerable, especially for the case of slow speed inductor generators, and they exert a marked influence on the performance and weight of such machines.

The defects of the inductor generator are, therefore, firstly: increased weight and cost, owing to the poor utilization of the armature copper, and owing to the heavy and harmful leakage fluxes. Secondly, poor pressure regulation (especially on inductive loads), due to the leakage fluxes, and to the extra reaction and leakage of the armature system, brought about by the ineffective portions of the armature winding, which are of course traversed by the load currents. Thirdly, non-sinusoidal pressure waves, which are inherent to such a design, on account of the distribution of the magnetic flux entering the armature. Lastly, a not altogether satisfactory mechanical design and performance, due to the general character of the construction and to the small airgaps, leakage fluxes, etc.

The advantages of the stationary field and armature windings, and of the relatively small amount of copper required by the single exciting coil of the inductor generator, could not make up for the serious disadvantages stated above, and hence the type has become obsolete, although, as already indicated, it was given every chance, and abandoned but slowly. With one notable exception, makers passed on to the revolving field type of generator for heavy work, the exception being the Westinghouse Co., who have gone in largely for revolving armature generators. Fig. 4 represents such a machine,* the construction in question being, the writer believes, standard with this Company still. It possesses, at least, one advantage—that of cheapness—as the diameter can be kept down for the case of generators with very

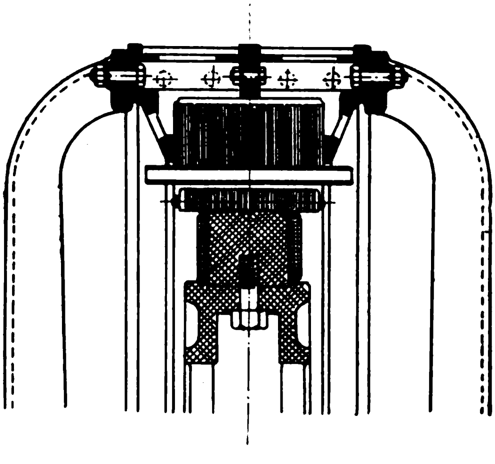


FIG. 7. FLYWHEEL GENERATOR WITH SPECIAL ARMATURE CONSTRUCTION.
(Brown, Boveri & Co.—standard).

---

* This is one of the five two-phase generators installed in the Willesden power station of the Metropolitan Co.; each is rated at 1,500 kilowatts, 60 cycles, 116 revolutions, and 500 volts per phase.

many poles, owing to the field system being external, and again, as the latter is stationary, the laminated pole cores can be cast into, and with, the field yoke.

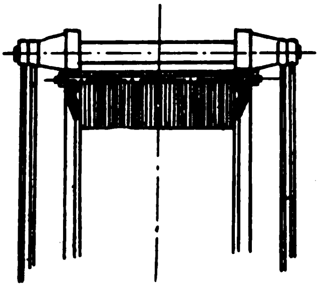


FIG. 8. PORTION OF A "BRACED" ARMATURE. (*A.E.G.—standard*).

For small work (100 kilowatts and less) polyphase generators of the revolving armature type can be successfully built as long as the pressure does not exceed about 2000 volts. Small machines of this type are, weight for weight, electrically better (and cheaper) than those of the revolving field type, as the amount of idle material in the armature is less, and the field poles are not so crowded; thus on the one hand there is somewhat less loss in the armature, while on the other hand, the external field system has less magnetic leakage, plenty of room for the exciting bobbins, and an ample radiating surface. But although the armature slip rings and brush gear can be properly insulated for pressures of the above mentioned order without difficulty, it is evident that the collection of high pressure current is, under any circumstances, inadvisable, and further, that it is far preferable for the high pressure windings to be stationary. For these reasons, most makers prefer, nowadays, to construct even the smallest machines with revolving field systems, for, at the expense of somewhat increased cost and somewhat impaired electrical performance, all exposed metal at high pressure is done away with, and the armature windings being stationary, can not only be more easily insulated in the first place, but the insulation itself is far less likely to deteriorate with time.

In order to keep the diameter of such small machines down, and at the same time to get more room for the field coils, Mr. Brown brought out, many years ago, the design of revolving field generator shown in Fig. 5. The magnet wheel is of cast iron, the (unwound) poles being cast with it; the separately bolted on (wound) poles are of circular wrought iron, the pole-shoes being forged with them; being of greater permeability than the cast iron unwound poles, they are of correspondingly smaller section. The cast poles are dished out, as indicated, in order to leave sufficient room for the exciting coils; each of the latter carries the number of turns necessary for one pair of poles. Many polyphase generators of this pattern have been installed in the past by the original makers and by others, in sizes up to about 300 kilowatts, and have been perfectly successful. It must be noted, however, that the unwound poles are always somewhat weaker than the wound poles, which results in a slightly unsymmetrical and distorted pressure wave; the magnetic leakage of such a system is, moreover, very considerable.

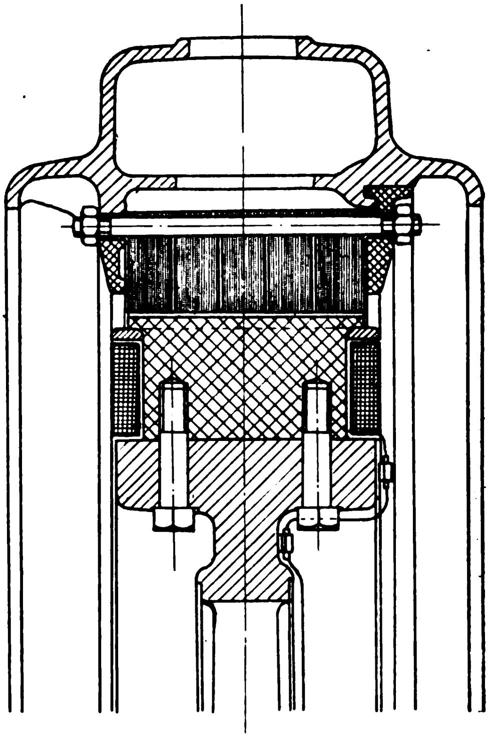


FIG. 9. REVOLVING FIELD GENERATOR. (*Electricité & Hydraulic Co.—standard*).

The writer believes that the pattern is now more or less obsolete, perhaps on account of these disadvantages, and probably also because it is a manufacturing advantage to have a standard type of machine for all sizes, even at the expense of relatively greater works costs for the machines of small output.

Coming now to modern patterns of revolving field polyphase generators designed for large outputs at high pressures, considerable differences will be found in the details of the design, even for the case of machines built to operate under identically similar conditions. For instance, some makers prefer solid pole-cores and pole-shoes, others solid cores and laminated shoes, while others again prefer laminated cores and laminated shoes, and similar differences will be noticed with regard to the principal details of the design. Only in one respect is there uniformity among the different makers—in all cases where the excitation pressure will allow of it, the winding of the field poles consists of bare copper strip on edge.

In a paper read at Manchester last year,* the writer dealt at some length with the general considerations underlying the construction of polyphase generators of the revolving field type, and, therefore, a short discussion of the matter on this occasion will suffice; an examination of a few modern designs will be enough to bring out the principal points.

Figs. 6 and 7 illustrate two revolving field generators of typical construction: the first is a 3,000 kilowatt 10,500 volt two-phase machine at 60 cycles and 75 revolutions; the second a 1,600 kilowatt 14,000 volt three-phase machine at 42 cycles and 180 revolutions per minute; both machines were built for similar work, namely, for the supply of sub-station machinery, situated at the end of a transmission line of considerable length. Yet the differences with regard to the electrical and mechanical details of construction are very marked.

With such large machines, one of the most important points to be considered in connection with the mechanical design is the stiffness of the armature construction. On the one hand the armature is a built up structure, of large diameter and great weight, and is subjected to stresses, due not only to its own weight, but to the magnetic pull, to the expansion and contraction caused by the change of temperature of the cone, and to the changing magnetic flux in the core. On the other hand, the air-gap or clearance between it and the revolving field system must not only be very small, on account of electrical and magnetic considerations, but it must be uniform all round in order to avoid unbalanced stresses on the whole machine, due to unequal magnetic pulls. The armature construction and arrangements must, therefore, be such that any serious deformation after erection is made impossible, under all conditions of service; further, they must be such that either the air-gap can be adjusted to (practical) equality all round when the generator is erected, or else they must be such that the parts will only go together when the armature core is concentric with the magnet wheel.

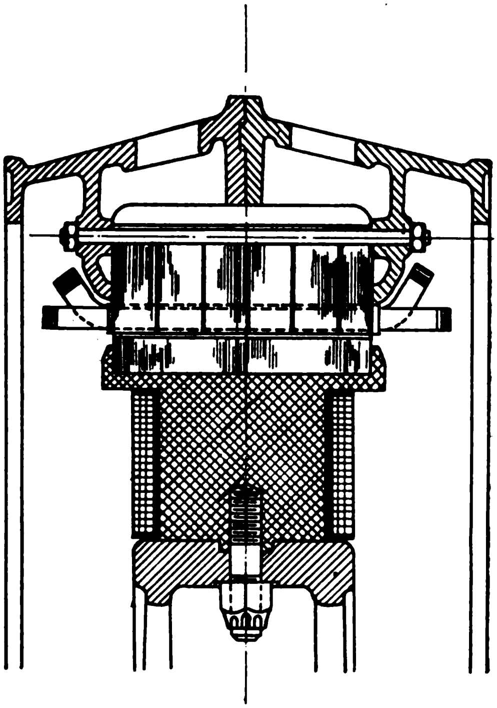


FIG. 10. SMALL REVOLVING FIELD GENERATOR. *(Kolben & Co.—standard).*

The armature of the generator shown

---

* See *Engineering*, June 6th, 20th and 27th, 1902.

in Fig. 6 is provided with feet, which stand upon sole-plates let into the foundation in the usual way, and hence, for the most part, the upper portion is subjected to compressive stresses, and the lower portion to tensile stresses. In order to prevent serious deformation of the armature structure, not only is it specially designed for great stiffness, by means of an exceptionally deep and heavily ribbed casing, but the lower portion is provided with four additional points of support, consisting of adjustable screws placed in the generator pit, which take most of the weight and entirely prevent sagging. The adjustment of the air-gap, in the first place, is made by means of these screws, and by similar screws passing through the feet of the armature casing, and bearing upon the sole-plates.

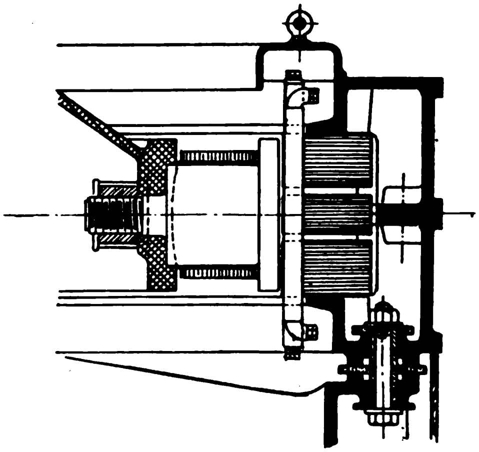


FIG. 11. VERTICAL SHAFT FLYWHEEL GENERATOR. *(Brown, Boveri & Co.—standard).*

The above method of obtaining the necessary rigidity of the armature structure consists, then, in putting enough metal into the casing, and in relieving the latter from its worst stresses. The same object is attained for the case of the generator shown in Fig. 7 in quite another way; here, a much smaller weight of idle material, more scientifically disposed, gives an equally good result. In this case the armature casing is carried by cast iron spider frames, which are supported from the main bearings. With this construction the armature bore is truly concentric with the magnet wheel, and the adjustment of the air-gap does not depend upon the erector, as the machine will only go together in one way; the air-gap is the same at all points of the armature periphery, as long as the bearings are in good condition, and, owing to the great rigidity of the armature (due to the radial arms which carry it), no deformation of any kind is possible. Other advantages of the arrangement are that no sole-plates are required for carrying the armature, and that, by removing a few bolts, the whole armature can be readily turned on its centres in order to bring up the lower armature coils into an accessible position for cleaning, etc.

Another method of centering the heavy armatures of large generators consists in building up the core in a light casing, or between stout end-plates, boring it out in a horizontal boring mill, and then pulling it true after erection by means of tie-rods. Sometimes these tie-rods are radial (Schuckert), and sometimes arranged as sketched in Fig. 8 (A. E. G.); such "braced" armature constructions have, it is thought, little to commend them except their cheapness, while they present various mechanical disadvantages.

For the case of generators of small and medium size, there is no difficulty in attaining the necessary rigidity for the armature structure without the provision of special arrangements; typical designs of armature casings are shown in Figs. 9, 10, 11, and 12, given later on.

The armature coils of the generator shown in Fig. 6 are former wound in open slots, there being three slots per pole per phase; those of the generator shown in Fig. 7 are hand wound in circular holes, there being one hole per pole per phase. The open slots in the first mentioned design, of course, demand laminated pole-shoes, and it will be noted that these are cast with the oval steel poles. With hole windings, solid pole-shoes can always be used, provided there are two or more holes per pole per phase (Figs. 9 and 11); this is not the case in Fig. 7, a single hole being employed in this case in the interests of better insulation of the armature windings. Hence, in this case also, the pole-shoes are laminated, these being rivetted up separately, and then bolted on to the separately forged pole-cores; in this particular design the pole-shoes form a cap to the pole-cores, and the fixing bolts (two per pole-shoe) pass partly through the cores, and partly through the shoes, acting thus also as keys, the whole construction being an exceedingly good one mechanically.

When solid pole-cores are employed, there is no difficulty in effectively securing them to the rim of the magnet wheel, in spite of the considerable stresses to which they are subjected at the high peripheral speeds (6,000 to 7,000 feet per minute) usual with the "all steel" wheels generally used nowadays. Some makers simply bolt on the poles as shown in Figs. 6, 7, and 9, while others prefer to dovetail them into the rim of the wheel, or to let them in radially (as in Figs. 10 and 11). The generator shown in the latter figure is a vertical shaft machine, direct coupled to a quick running (water) turbine; the forged pole-cores are deeply let into the magnet wheel, and their extremities are turned down, forming a massive bolt, a steady pin being, of course, also provided. Pole-cores which are let into the wheel radially possess the disadvantage that their removal, should this ever be desirable, necessitates the armature being disturbed —that is, either racked sideways, or the upper half lifted off, etc., and hence, from this point of view, a construction which allows the poles to be withdrawn laterally is preferable. But in this connection, it must be noted that it is very rarely indeed that faults develop in the field windings of this class of generator of such a nature as to necessitate the removal of the poles; while, on the other hand, it is common practice to provide arrangements for racking the armatures sideways, for the purpose of getting at the armature coils. This is not by any means absolutely necessary, however, as the lower armature coils can be rendered accessible in other ways, as already noted for the case of the generator shown in Fig. 7. The generator shown in Fig. 9 is also arranged in such a way that the lower armature coils can be got at without moving the armature sideways: in this construction, the armature stands upon distance pieces (heavy cast iron plates) which are placed between the feet and the sole-plates proper. By removing these, the armature can be let down on to the magnet wheel, and rotated with the latter in the pit, thus bringing the lower coils up to the floor level.

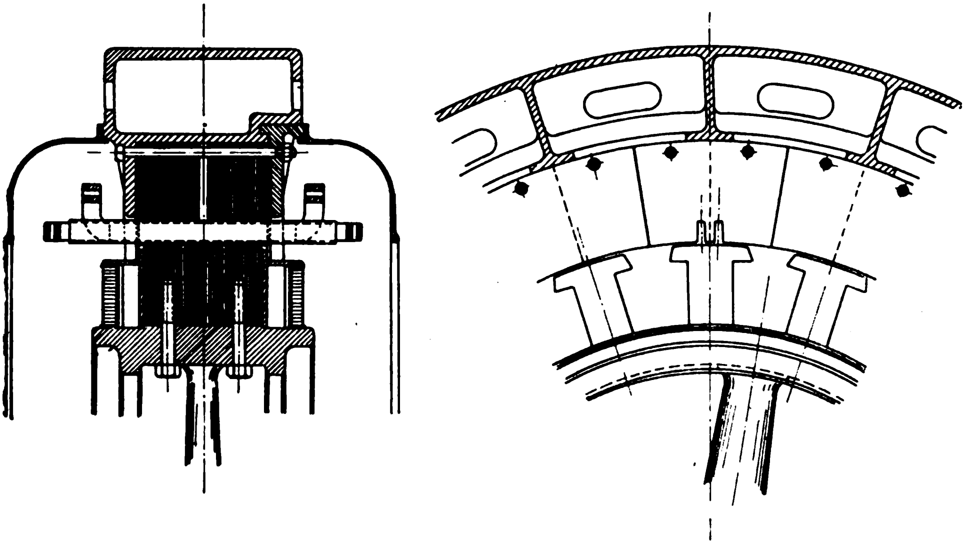


FIG. 12. FLYWHEEL GENERATOR. *(Oerlikon Co.—standard).*

Generally speaking, and especially when the generators are placed between the cranks of the driving engines, it is preferable to adopt this method of turning the armature, or else that of Fig. 7, rather than to make provision for shifting it sideways, in order to shorten the shafts as much as possible. Either of these methods demands that the poles shall be capable of being withdrawn sideways, firstly on account of the field coils, as already noted, and secondly because, if former wound armature coils are employed, a few poles have, with these constructions, to be removed before a defective armature coil can be taken out and replaced by a new coil. Instead of employing solid pole cores with laminated shoes for the case of generators having former wound coils in open slots, several makers prefer to laminate the poles throughout, as shown in Figs. 12 and 13, and in this case it is more difficult to make a really good mechanical connection between the poles and the rim of the magnet wheel. It is usual to limit the speed of field systems of this class to 5,500— 6,000 feet per minute, especially when the bolts are screwed directly into the laminations, as in Fig. 12; in Fig. 13 it will be noted that the bolts are screwed into a solid iron bar which passes right through the laminated pole-core. Incidentally it will be observed that in both designs the field spools are arranged for internal ventilation at the expense of a somewhat greater mean length of turn, which is made up for, however, by the greater current density which can be employed in the field winding. As a matter of fact, in general, the best way of securing such laminated poles to the rim of the wheel is to dove-tail them in, and, in addition, to secure them somewhat after the manner of Fig. 13.

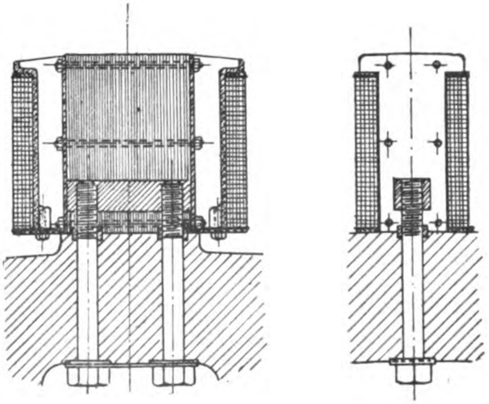


FIG. 13. LAMINATED POLE CONSTRUCTION.
(Siemens & Halske—standard).

As a final example of a modern construction, the pattern of "outer-pole" polyphase generator shown in Fig. 14 should be particularly noted; considering the special advantages possessed by this construction for the case of large slow speed generators, it is somewhat surprising that such machines are only made by the originators of the type—Messrs. Brown, Boveri & Co.

The stationary internal armature of these machines (made in two parts) is carried on a central hub forming part of the heavy sole plate carrying the outer bearing, or the bearing nearest the armature, as the case may be, and can be barred round on this hub to get at the lower coils; the field poles are carried on the inside overhanging rim of the cast-iron fly-wheel, as indicated. It is clear that, contrary to the conditions prevailing with all other patterns of revolving field generator, the magnetic pull works against the centrifugal forces, which is an advantage not to be despised. In the writer's opinion, however, the great advantage of these outer-pole generators lies in the fact that the fly-wheel effect required by the engine builder can be readily arranged for in the magnet wheel without sacrificing the electrical design of the armature to the mechanical requirements; this is frequently necessary (especially with 25 cycle machines) for the case of fly-wheel alternators of usual design, as, in order to provide the necessary fly-wheel effect, the generator has to be made narrower and of greater diameter than would otherwise be necessary. In the outer pole pattern, the armature is designed simply from the point of view of the electrical and magnetic requirements, and whatever fly-wheel effect has to be provided is then easily arranged for in the external wheel.

For the case of polyphase generators which have to be coupled to steam turbines, it goes without saying that none of the designs referred to above would be suitable without very considerable modification. Turbo-generators are essentially machines of small diameter and relatively great width, and while any other type but a revolving field generator is out of the question as far as heavy high pressure work is concerned, yet it is a great question whether any form of field system arranged with wound polar extensions could be used with good results. In the design of turbo-alternators, the principal mechanical difficulties to be got over are those connected with the design of the rotating parts from the point of view of resisting the stresses brought about by centrifugal force, and secondly, the difficulties connected with the proper balancing of the rotating field system. The principal electrical difficulty is in connection with the pressure regulation of the generators on inductive loads, for, owing to the necessarily small diameter of the field system, it is difficult to put that amount of copper into it which is really necessary in order to keep the effects of armature reaction within the limits necessary for good pressure regulation. These difficulties increase with the frequency and, to a certain extent, with the width of the generator, as in both cases the magnetic leakage of both armature and field systems increases. From this (the pressure regulation) point of view, the revolving armature turbo-alternator presents considerable advantages, but this pattern, as already noted, is inadmissible on other grounds.

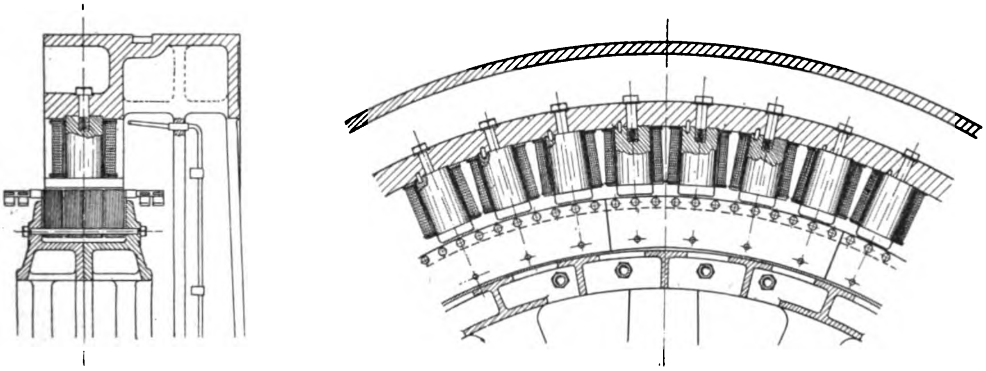


FIG. 14. OUTER POLE FLYWHEEL GENERATOR. *(Brown, Boveri & Co.—standard).*

The type of field system which gives the best results at present for this class of work is one in which the polar windings are placed in deep slots or holes arranged around the external periphery of a solid or laminated steel structure, the wound field system thus resembling somewhat the rotor of an induction motor. Either drum or ring windings can be used, the former being better magnetically, the latter being better mechanically. With either winding a field system is produced which can be readily balanced, and in which the windings are properly secured against shifting by centrifugal force. In either case the end connections are held in by dished out gun-metal rings, and in either case the revolving parts are practically smooth all round, resembling externally, when finished, simple metal cylinders.

The principal improvement which may be expected in the near future with regard to the present patterns of polyphase generators will probably be in the direction of improving the pressure regulation with the help of compounding arrangements which will, at the same time, not impair the performance of the machines from the point of view of parallel running and general all-round reliability. In this connection it may be observed that the recent work of Mr. Alexander Heyland appears to indicate that the complete solution of a very difficult problem—that of making polyphase generators self-exciting and compounding, not only with regard to the magnitude of the load, but also with regard to its power factor—is not far off. Quite a number of really large three-phase generators, having different speeds, frequencies, etc., and provided with compounding arrangements on the Heyland principle, are now in course of construction, and in a short time it will be known whether the good results obtained with the small trial machines are confirmed.*

It should be particularly noted that the compounding arrangements in question do not entail any structural alteration whatever to the standard revolving field generators of to-day. The armature winding remains the same, and the field structure also; the latter is merely wound with a number of parallel circuits, instead of a single one, while a small commutator takes the place of the usual direct coupled exciter. This commutator is connected up to the various ends of the field winding in a special manner,* and is supplied with exciting and compounding currents indirectly from the generator terminals through current and pressure transformers. Its function is, first of all, to rectify the three-phase current, led into it by the brushes, into a uni-directional current; and, secondly, to split up the former into its two components in such a way that that part of the field excitation, due to the wattless component, alters proportionately with the magnitude of this component alone. The net result is that, with a given adjustment of the field regulators, and a certain value of load current, the terminal pressure will be, for instance, 5 to 10 per cent. greater than the no load pressure, according to the power-factor of the load current; the pressure being highest when the power-factor is lowest. This is exactly what is wanted in practice, seeing that for a given load current the drop in the transmission lines, transformers, etc., is greatest when the load is highly inductive.

---

* Since writing the above, several of these generators have been tested and set to work, with excellent results.

In the writer's opinion, Mr. Heyland's work constitutes the most important advance which has been made in connection with the design of alternating current generating machinery during the last few years. It is not so much the actual results attained to date, but the new field and order of ideas which have been opened up by his researches that are of such great interest and value to those interested in this branch of electrical engineering.

A. C. Eborall

---

* See "On Induction Machines and a New Type of Polyphase Generator," *The Electrician*, July 3rd and 10th, 1903.

Next month will appear in this section, the first of a series of articles on Electricity in Mining and Metallurgy, by Percy R. Allen, A.M.I.C.E., A.I.E.E. A number of unique photographs will illustrate the series, and among other apparatus, some special electric winding engines will be described. These machines will be found of exceptional interest to colliery proprietors who are now considering the value of electricity for replacing their old steam-driven winding engine plant.

THE THEORY OF ALTERNATORS.—I.

By ALFRED HAY, D.Sc., M.I.E.E., etc.

INTRODUCTION.

THE problems which the electrical engineer has to deal with are in general so complex that in most cases an approximate solution only is possible. Especially is this true of alternating currents, where any attempt to take *all* the effects into consideration would baffle the powers of the most accomplished mathematician. All that can ever be hoped for, is a more or less close *approximation* to the actual facts of the case. Indeed, it is probably no exaggeration to say that most mathematical solutions of physical problems are only more or less coarse-grained caricatures of nature, which are incapable of standing the searching light of refined criticism, but which, nevertheless, serve an extremely useful purpose, and, like the productions of the modern impressionist school of painters, possess a beauty and elegance which cannot fail, apart from their utilitarian aspect, to appeal to the scientific imagination of all but those who are always in the habit of examining everything with a microscope of the highest magnifying power.

Among alternating current problems, there are probably few on which so much has been written as those presented by alternators, when used either as generators or as synchronous motors. The literature of the subject is very extensive—so extensive, indeed, that probably only very few electrical engineers could afford the time for its careful study. Nevertheless, to an engineer who has to deal with alternating current plant some knowledge of what has been done in this direction is most desirable, as it would in many cases enable him to simplify his tests, as well as to draw important conclusions from them regarding the probable behaviour of the machines under varying conditions of load, and in many instances to arrive at a correct explanation of effects which, without such knowledge, would appear extremely puzzling.

Important as is some knowledge of the theory of alternators to the central station engineer, to the designer (or one who aspires to become such) of alternating current machinery it is absolutely essential, and probably the most minute and careful study of the subject will well repay the labour spent upon it. In the present series of articles, we shall attempt to give a connected account of what has, up to the present, been accomplished in developing the theory of alternators. In so doing, we shall endeavour to present all the essential points of the various theories which have been advanced at different times in as simple a manner as possible, and shall in every case insist on the purely physical (as distinguished from the mathematical) aspect of the subject.

The terminology of our subject is, most unfortunately, in a somewhat chaotic state, and various writers use the same terms in totally different senses. We shall, therefore, take special care to define clearly the various terms which we shall have occasion to use, and also to point out the meanings which are at times attributed to them by other writers. If this series of articles accomplishes no other useful purpose, it will at least serve to clear the ideas of those interested in the subject, and to put them on their guard against the many pitfalls which beset the unwary reader who imagines that a technical term used by a writer on alternator theory necessarily always denotes the same quantity.

The methods we shall employ will be very largely graphical ones, involving the use of vector algebra, and with these the reader will be expected to be familiar. A knowledge of the elements of alternating current theory will, of course, be also assumed. The use of mathematical analysis will, wherever possible, be avoided, and in cases where recourse is had to differentiation or integration, an endeavour will be made to give an alternative mode of treatment not involving a knowledge of these processes, for the sake of readers who do not happen to be very familiar with them.

General Principles and Terminology.

Any apparatus intended for the generation or transformation of alternating currents may be analysed into two systems, an *inducing* and an *induced* one. The *induced* system (Fig. 1) consists of the circuit in which alternating currents are induced by a periodically varying magnetic flux. The *inducing* system consists of a circuit which is instrumental in producing the magnetic flux. The inducing circuit may be supplied with either a continuous or an alternating current, and the necessary periodic variations in the flux linked with the induced circuit may be brought about in one or other of the following three ways:—(*a*) By a displacement of the induced relatively to the inducing circuit, the current in the inducing circuit being a continuous one and remaining practically constant; (*b*) By the use of an alternating current in the inducing circuit, the induced circuit being stationary; (*c*) By a combination of these two methods, the inducing circuit carrying an alternating current, and the induced circuit being at the same time allowed to move. Method (*a*) is the one adopted in alternators of ordinary construction, in which the field circuit represents the inducing, and the armature circuit the induced, system; method (*b*) is used in ordinary alternate-current transformers, in which the primary forms the inducing, and the secondary the induced, system, and in which there is no mechanical motion; while method (*c*) is adopted in induction motors and generators.

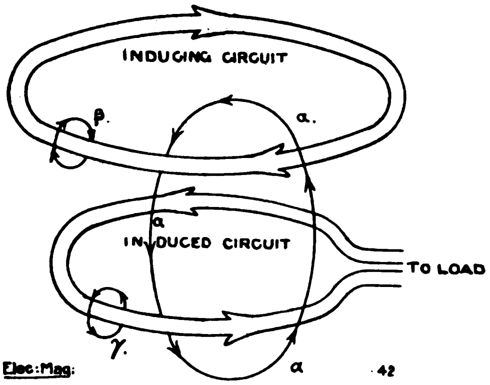


Fig. 1.

The performance of any one of the various types of apparatus just mentioned may be said to be conditioned by the following three quantities (Fig. 1): (α) the magnetic flux which is common to the two circuits, and which forms a magnetic link between them; (β) the flux which is linked with the inducing but not with the induced circuit; and (γ) the flux linked with the induced circuit but not with the inducing one. It is to be noted that all these magnetic fluxes have a *real physical existence.* In addition to these fluxes, it is in some cases convenient to consider the following two *imaginary* magnetic fluxes: (δ) the *total* flux which would become linked with the inducing system if the current in that system were maintained at its original value, and if the current in the induced system were totally suppressed; (ε) the total flux which would become linked with the induced system if the current in it were to remain unaltered, and the current in the inducing system were suppressed. We thus have to deal with altogether *five* different magnetic fluxes. A good deal of the confusion which has arisen in dealing with problems relating to alternating-current machinery is due to failure to distinguish carefully from one another the various magnetic fluxes we have just enumerated, and to the neglect of the fact that, while some of these fluxes have a real physical existence, others are purely imaginary. On account of the great importance of the subject, we shall devote some space to a thorough discussion of the relations connecting the various magnetic fluxes, and of some other quantities closely related to them. It may be mentioned, in passing, that while most *modern* theories are concerned with a consideration of the fluxes (α), (β) and (γ), *i.e.*, the fluxes which have a real physical existence, the introduction of the imaginary fluxes (δ) and (ε) is specially characteristic of all the *older* theories.

(To be continued.)

Alfred Hay

MUNICIPALISATION AND THE ELECTRICAL INDUSTRY.

By A. G. WHYTE, B.Sc.

I.

According to a familiar saying, every nation has the government which it deserves. One might infer from this that every industry has the legislation it deserves; but, in the case of the electrical industry at least, the inference does not hold. In fact, the laws governing electric traction and the public supply of electricity for lighting and power purposes were drawn up, in a sense, before the electrical industry was born. They were drawn up at a time, moreover, when public opinion was in such a condition that the unborn industry was wedded, by proxy and by anticipation, to the attractive idea of municipalisation. The later history of that union has not altogether disproved the axiom that marriage is a lottery.

In 1870, when the Tramways Act was passed, there was a strong current of feeling against public monopolies. Gas and water companies had held almost unrestricted rights of supply in their particular districts, and they had in some cases abused the freedom given to them. The development of tramways created a public service which was bound to be a monopoly of some kind or other, since competing tramway companies were practically out of the question in the great majority of English towns. Parliament recognised this, and, in order to guard against the repetition of abuses, it passed a law which bound the monopoly holders hand and foot, and placed them at the mercy of the local authorities, who represented the public interests. That was the spirit of the Tramways Act, 1870; and the three main principles which it embodied were grafted on to the Electric Lighting Acts of 1882 and 1888. These principles were: (1) That the local authority should have an absolute right of veto over any company proposing to lay down tramways in its area; (2) that the term of tenure enjoyed by the company should be limited, (to 21 years); and (3) that at the end of the period of tenure the undertaking should be purchasable by the local authority at its "then value" without any allowance for compulsory purchase or goodwill.

It is astonishing how deep a stamp these three provisions, framed apparently in the public defence, have made for ill on the electrical industry. Experience has shown that, if the lovers of monopoly went too far in the early days of gas and water companies, the haters of monopoly went too far in the early days of tramways and electric lighting. The laws they framed with a view to control proved oppressive, and in one case absolutely repressive. They had the effect of retarding electrical progress in every branch—traction, power, and lighting; and they had also the effect of opening the door to municipalisation. It is with this last effect—the forced development of municipal electrical enterprise through mistaken legislation, and its influence on the prosperity of the electrical industry—that we are now mainly concerned.

For many years after 1870 the true inwardness of the Tramways Act was not recognised. The veto had not proved particularly obstructive, since at that early date the spirit of municipal trading was hardly alive, and there was no call for local authorities to speculate in horse tramways. Even in 1882, when many tramway companies had only about nine or ten years of life left to them, the meaning of the compulsory purchase clause had not been widely realised. Exactly the same principles were, as we have stated, embodied in the Electric Lighting Act without any general protest. It is certain, at least, that the Government had not foreseen the process which occurred a few years later, when tramway company after tramway company found itself approaching its deathbed. The last years remaining to them were shadowed by the certainty of being sold up at less than their fair market value as going concerns. They had, in fact, to face partial confiscation, and they faced it with a passive resignation which was in its way a protest. They refused, naturally enough, to spend money on improvements, when they knew that there was no time to recoup the outlay. They set themselves to save expense, so as to provide as best they could for the day of dissolution at scrap-iron value. Rolling stock became dilapidated; the track was allowed to get out of order; the horses were worked to the last kick; and the men's uniforms became so threadbare by long use that in after years the provision of new coats and bright brass buttons for the drivers and conductors became a cardinal point in tramway reform.

In short, the purchase clause of the Tramways Act prevented the companies giving an adequate and up-to-date service during the last years of tenure. Inevitably, the public was dissatisfied; and as the man in the street knows nothing of tramway laws and purchase clauses, the tramway companies were roundly abused. Inevitably, also, the local authorities were called upon to take over the tramways and re-organise them on a satisfactory basis. Thus was the impulse towards municipalisation supplied and made imperative by an Act of Parliament. At the same period —towards 1890—electric traction had been developed to a commercial stage, and had proved its economical superiority over horse and steam traction on tramways. The demand for municipal ownership was therefore coupled with the demand for electric traction; but the local authorities hesitated over the latter revolution. They sent innumerable deputations to the Continent and to America, and they held innumerable debates about the dangers and ugliness of the overhead system. The result was that, while the introduction of electric traction had been delayed in the first place until the various tramway concessions expired, it was further delayed by the over-cautious attitude of the local authorities towards the adoption of the new system. The Tramways Act had brought municipalisation, and municipalisation had brought delay.

Other troubles were, however, making their appearance. Several tramway companies were anxious to adopt electric traction, but the change was out of the question with only a few years of life left to them. They sought to obtain an extension of tenure in order to justify the heavy expenditure on electrification; but here the veto possessed by the local authorities was brought into action. The desired extensions were in most cases refused. Similarly, companies which sought concessions in virgin districts were vetoed in obedience to the growing impulse of municipal trading and the general feeling against tramway companies. Thus the Tramways Act brought about the partial suppression of private enterprise in electric traction development.

The main trouble centred in the organisation of inter-urban tramways—those networks of lines which are as characteristic of electric traction as the parochial tramway system was of horse traction. The necessity of dealing with a dozen or more local authorities, each possessing the power of veto, proved very irksome; and where there was a division of control between companies and municipalities, or between municipalities themselves, over a system which would, by nature, be a single coherent undertaking, the difficulties of obtaining inter-connection became very formidable. Each municipality clung to the idea of owning and working its own tramways, oblivious of the fact that electric tramways, to be of real use to the public, should ignore parochial boundaries and link town to town. Manchester and Salford took three years to arrange mutual running powers; Leeds and Bradford adopted different gauges; Wolverhampton cut itself off from connection with outside districts by adopting a surface-contact system; Birmingham imperilled the public usefulness of an extensive inter-urban system by adopting municipalisation. These are a few cases by way of illustration. It is quite well known, however, that the hardest part about modern electric tramway enterprise is to induce the local authorities to recognise the importance of free inter-communication and the necessity of modifying their parochial ambitions in the interests of their neighbours and themselves.

For these reasons the development of inter-urban tramways in England is far behind the stage it has reached in other countries. Municipalisation gave us, late in the day, urban electric tramway systems —magnificent, no doubt—but no more efficient than those which companies have provided in Bristol, Dublin, Middlesbrough, or West London. It has proved itself a formidable barrier to the extension of local tramways into comprehensive systems serving a score of districts. In the Black Country, in Northumberland, in South Lancashire, in the West Riding, and in many other quarters, the existing tramway systems are in an incomplete condition, not for lack of money or enterprise, but simply because the law and the municipal spirit have erected almost insurmountable obstacles at every parochial boundary.

II.

TURNING now to Electric Lighting. Here the effect of laws, framed with a view to municipalisation, was definite, and, for a time, disastrous. The Electric Lighting Act, 1882, was framed with the most benevolent intentions. Mr. Chamberlain was then President of the Board of Trade, and full of well-meaning reforming zeal. But the Act stopped electric lighting enterprise until 1888, when an amending Act was passed. Capital could not be obtained under the 1882 Act, because people had begun to get an inkling of what the 21 years' tenure, with compulsory purchase, really meant. They realised, too, that, as an electric lighting business would take three or four years to get properly under weigh, the actual life of the business would be shortened by several years. The municipalities themselves did not take up electric lighting; they were not intended to be pioneers. They woke up, however, in 1888, when the period of tenure was extended to 42 years and the purchase clause slightly improved. Then the applications from companies for electric lighting provisional orders came with a rush. The local authorities, finding that they possessed a power of granting or withholding a right which several interests were anxious to obtain, took an exaggerated view of the value of Electric Lighting Orders. They exercised the veto on a large scale; they took out orders themselves, sometimes, no doubt, with the intention of working them, but often merely as "blocking" orders to keep out a company and save the municipal gasworks from competition. Here, again, the law brought municipalisation, and municipalisation brought delay.

After electric lighting development had finally got under weigh, the municipalities came to play a part in regard to electricity supply similar to that which they adopted with regard to inter-urban tramways. In the same way as electric tramways had begun to over-run the areas of several local authorities, so it was found that the economical production and distribution of electricity required a large undertaking working over areas of several hundreds of square miles. The districts of individual local authorities became insignificant in comparison with the range of distribution which electrical engineers sought (in 1899) to attain under what were known as the "Power Bills." Every effort was made by the local authorities to oppose these "Power Schemes," and to limit their rights and their areas of supply. The large towns in which there was already a municipal supply of electricity were exempted from the benefits of a cheap competitive supply of electric power. In this, the most important branch of electrical enterprise, the spirit of municipalisation has opposed advance stubbornly step by step.

III.

IT has now to be considered whether municipalisation has brought any compensating benefits to an industry which it has retarded and obstructed. Are municipal tramways and municipal electric lighting undertakings so conspicuously superior to those in the hands of companies, that we can look with complacence on the obvious drawbacks which have been described? The question hardly requires an answer, because, while the evidence of municipal backwardness, obstruction, and parochialism is eloquent in every department of electrical enterprise, the superiority of municipal over company working remains unproved. That is putting the matter in a moderate way, since municipal electrical finance is the object of continuous criticism, which seems to grow in force as time goes on and experience accumulates. Belief in the superiority of collectivist over joint-stock trading is becoming more a matter of faith than of conviction; it is a faith which is very much on its defence. Even the public is beginning to realise that men elected for political reasons and local government purposes are not necessarily the best managers of a highly specialised trading concern.

We have to recognise, however, that

municipalisation is undoubtedly with us, and likely to stay so for many years. The practical question is, therefore, to discover how its faults may be cured; or, at least, counteracted. As regards electric tramway development, the situation has become so complicated that no simple remedy seems possible. The Light Railways Act, 1896, has enabled longer periods of tenure and more favourable terms of purchase to be arranged; and the Board of Trade has pledged itself to a measure which will remove the objectionable qualities of the veto. But these changes do not touch the main problem, which is to secure freedom of inter-communication between neighbouring systems under varied control.

The granting of compulsory running powers would go far to remove the difficulty where voluntary agreement has been found impracticable; in one or two cases Parliamentary Committees have, in fact, conferred such powers on a clear case of public necessity being made out. In some instances, however, there is so great a difference between the sizes of the neighbouring systems, that running powers on an equable basis are almost beyond human ingenuity. The only thing to do in such cases is for the greater to absorb the less; and if the less happens to be a municipal undertaking, the process may have its drawbacks. An actual case will make this point clear, and throw light on the ultimate effect of municipalisation on the electrical industry. In a district which it would be invidious to mention, a large system of tramways was being furnished by a company. The centre of the district was occupied by a town, not very large or important in itself, but forming the key to a wide system of inter-communicating lines. This town refused all overtures from the company, and decided to put down a municipal system of its own. A consulting engineer was called in, and, with a view to his commission on the capital expenditure, he designed the tramways on a very liberal scale, and included several lines up back streets, where tramways were quite superfluous and quite hopeless in a commercial sense. The system was constructed, and then the Corporation realised that it was more than half useless when isolated from the outside lines. Negotiations with the company were then re-opened; but an offer from the company to purchase the lines required for inter-communication purposes was rejected by the Corporation. The company was told that it must buy the whole system, superfluous lines and all, or go without. In the end, it will probably happen that the company will have to burden the whole of its system with the useless expenditure on these back street lines. The travelling public in a wide district will, therefore, be the losers through the extravagance of a single local authority.

This case, which is by no means exceptional in character, illustrates a point which has not been sufficiently dwelt upon in connection with municipalisation. If a tramway company found itself burdened with lines which were commercially a failure, it would, in the ordinary course of business, abandon them and write off the loss. In a municipal undertaking, however, there is no such provision for wiping out dead capital. The lines may be abandoned, but interest and sinking fund have to be paid on the cost of them till the end of the chapter. For that reason municipal extravagance and mismanagement have a permanent effect; the ratepayers of to-morrow have to go on paying for the follies of the representatives of the ratepayers of to-day.

IV.

In many quarters there are visible signs that local authorities are beginning to modify their inherent parochialism, and adapt their policy to wider interests than those of their particular districts. As far as electric lighting is concerned, established municipal undertakings will probably continue to retain their separate existence, and to stand aloof from the amalgamation which gives economy. But the note of co-operation between companies and municipalities is not altogether absent. It is a common thing now for local authorities holding Provisional Orders to purchase electricity in bulk from a big power company, instead of erecting a small separate generating station for themselves. Under this arrangement the local authority becomes, at the same time, a wholesale customer and a retail merchant. Theoretically, it would be a better thing for the company to have the whole business under its own uniform control; but a compromise which enables the company to extend its business of production and distribution on a large scale, and yet enables the local authority to retain the cherished lighting monopoly in its own hands, is not to be lightly treated.

An adequate treatment of the effect of municipalisation on the electrical industry would require a volume, but the bare outlines of the subject make it clear that the industry has small cause to be thankful that a combination of law and chance brought it so early under the wing of the municipal trader. Lighting, Traction and Power devolopments have each in turn been delayed and restricted in obedience to parochial trading ambitions, which have further brought them into an almost chaotic condition. Time, no doubt, will join up the broken ends and weld the isolated fragments, but time will never atone for the losses which the conflict of interests has brought about. It must not be forgotten that the Parliamentary struggles, the delays, the uncertainties, the restrictions, the segregation of enterprises which are economically a unit, the whole army of difficulties which have, through municipalisation, beset the electrical engineer for the last twenty-five years—it must not be forgotten that these adverse conditions involve increased expenditure which is a burden, temporary or permanent, on the whole electrical industry.

For that waste of money there is no compensation; and the only useful hope is that the reform of electrical legislation and the broadening of the municipal mind will help to reduce it, if not extinguish it, in the near future. The Board of Trade has practically pledged itself to bring forward measures amending the worst features of the existing laws relating to electricity supply and electric traction, but in the congested state of Parliamentary business no reliance can be placed on the early success of these necessary amendments. Necessary they are, nevertheless, for it is absurd that the industry should still be dominated by the parochial ideas of 1870. Meanwhile, there are clear signs that the municipal world is gradually abandoning its narrow creed and recognising that in electrical matters the policy of local isolation is wrong. Much of this beneficial change has been due to the efforts of municipal electrical engineers and tramway managers, who no doubt feel towards their committees as a radical House of Commons does towards a reactionary House of Lords. They have often supplied the impulse to co-operation in inter-urban tramway and other electrical schemes, and in time they may effect an alliance between interests which now regard each other as permanent enemies.

Adam Gowans Whyte.

[Further articles on the above subject from the pens of writers of repute will follow].—Ed E. M.

POWER: and its application to INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

INTRODUCTORY ADDRESS.

By G. W. de TUNZELMANN, B.Sc., M.I.E.E.

A COMPLETE electric power system is built up of three distinct components:—(1) The Power Station, where the electric energy is generated, that is, some form of energy obtainable in quantity is transformed into electric energy. (2) The Transmission System, by which the energy is conveyed to the place where its utilization is required. (3) The Utilization System.

The first two components will be dealt with in this section of *The Electrical Magazine* when the power station and the utilization system are stationary, except in the case of the comparatively small power required for telegraphy or telephony. The third component will be included only when the electric energy is finally transformed into mechanical energy by means of stationary motors.

The most striking features of recent power station progress are the steady advance in the employment of the steam turbine and the gas engine as prime movers for driving generators, owing to construction advances increasing the reliability and efficiency of these engines, and in the latter case, thereby making it possible to build satisfactory gas engines of steadily increasing size.

The placing on the market, last year, of the N.S. Power Station battery must also be recorded, as its novel and well considered method of construction bids fair to remedy much of the trouble encountered in keeping these batteries in good order.

In the course of last year two new undertakings for the supply of electricity in bulk came into operation, *viz.*, The Derbyshire and Nottinghamshire Electric Power Co., and The South Wales Electric Power Distribution Co., bringing the number of such supply companies up to six in all. Three others—The Clyde Valley Electrical Power Co., The Yorkshire Electric Power Co., and the Lancashire Electric Power Co.—are in course of construction, and others will soon be commenced.

These undertakings for the supply of electric energy on a large scale at cheap rates are causing a considerable increase in the extent to which electrical power is being utilized for industrial purposes.

The availability of reliable gas engines of large size should considerably assist this development, in one way at least, by facilitating the use of waste blast furnace gases for the supply of energy to electric power stations. The initial outlay on such stations would make it impossible to obtain power in this manner as cheaply as from water power under the most favourable conditions. The districts, however, in which water power is available are usually not very accessible, and when due weight is given to the expense of transport and other items of cost of manufacture, it would appear that the utilization of blast furnace gas, the present availability of which is mainly due to the untiring perseverance of our countryman, Mr. B. H. Thwaite, should enable power from this source to compete with Continental and American hydraulic electric power systems to an extent which is very little realized at the present time.

The prospect of cheap electric power which these large undertakings present, should not be lost sight of by British manufacturers. In the present day of keen foreign competition—

carried on under the most favourable power conditions by our commercial rivals—we hope soon to see all users of power, for whatever purpose, supporting these electric power companies, and at the same time benefiting themselves, by discarding old plant in favour of electric driving. The natural resources of this country, if fully and scientifically developed, are quite capable of affording the British manufacturer the same facilities for obtaining cheap power as other nations which have natural sources of power more readily available.

All the power schemes at present operating in this country deliver energy by underground cables, as overhead lines were forbidden by the Board of Trade at the time of their inception. A precedent will, however, be established in the case of at least two important power schemes, whereby overhead wires will be sanctioned, doubtless with corresponding benefit to the promoters themselves, while the effect upon consumers, in the shape of more favourable rates, will be almost certainly noticeable. Where underground cables are used, cable charging devices of some kind are usually employed.

The great saving in conductors obtained by the employment of high voltages in long distance transmission has led, in the United States, where the distances are great, to a continuous increase in pressure for some years past. This increase has introduced very considerable difficulties, mainly in connection with switch gear, insulation, and regulation, but their is every reason to believe that, as these are more and more completely met, transmission voltages will continue to show an upward tendency.

Pressures extending up to 60,000 volts have for some little time been successfully used in the United States, and the use of 80,000 volts is contemplated. Large transformers have actually been built for the latter pressure, with a view to the proposed increase, but though their behaviour under test gave every promise of satisfactory results in practice, there has not yet been any opportunity of working them commercially at the voltage for which they are intended, and at present they are operated at lower pressures.

In European transmission systems the distances are much less, and the highest pressure employed is in the recently constructed installation supplying electric power derived from the river Drac, near Grenoble, to the industrial valleys of the Fure and the Morge. The pressure employed in this case is 26,000 volts, although the distances are not great, the principal line, from the power station to Moirans, being only 35 kilometres, with extension lines to neighbouring districts. For long distance transmission over lines suspended on poles, hard-drawn copper is most commonly employed as the conducting material. For a given conductivity, the weight of aluminium is only half the weight of copper, and it has a greater tensile strength, and therefore longer spans may be employed, requiring fewer poles. These considerations make aluminium lines cheaper than copper at recent prices of the metals, and, in consequence, aluminium conductors are used in several of the latest American long distance lines. In the design of long distance power transmission systems, much consideration usually has to be given to the question as to whether monophase or polyphase current shall be selected. The former, with comparatively rapid alternations, is preferable for lighting, while for driving motors, a polyphase system is to be preferred, and, within practicable limits, the slower the rate of alternation, the greater is the motor economy obtainable.

A very ingenious system, due originally to Dr. Frederick Bedell, and greatly improved by Messrs. Arnold, Bragstad, and La Cour, enables currents of various character, including continuous currents, to be either sent into, or taken out of, a transmission system, at points of equal potential, without any resulting effect of the previously existing currents. The principal advantages claimed for this interesting system are as follows:—

(1) Separate generating sets are used for light and power respectively, so that the speed and voltage regulation are quite distinct, different frequencies can be employed, and phase displacement in the lighting machines is eliminated.

(2) The same brushes are used for lighting and power, giving a maximum simplification of apparatus.

(3) The step-up transformers may either be distinct for lighting and power, and at the same time interchangeable according to requirements; or they may be combined, without any resulting interference between the lighting and power circuits.

(4) The high pressure mains are common for lighting and power, but at the same time quite independent.

(5) Lighting installations are all on the two-wire system, and therefore of the simplest character, and motors of any size can be employed on the circuits, since the voltage variations due to the motors have no effect on the lighting.

The substitution, in factory work, of electric motor driving for the old system of belts and shafting goes on apace, even in this country, and though we are not abreast of American and Continental practice in this respect, it is satisfactory to note the progress being made. In Russia nearly all new factories of any importance are electrically driven. Belgium has taken the lead in the important and difficult work of adapting electric driving to iron and steel works, but America is not far behind, and quite recently our own Newport Steel Works have shown the way in introducing some very interesting electric transporting and crushing machinery. The Antwerp Steel Works, in addition to using electric driving for all accessory rolling mill purposes, as had previously been done at the Bethlehem Steel Works in the United States, are using it for driving the rolls themselves, except in the case of the very largest rolls. The use of electric driving for rolling mill accessory apparatus, in addition to effecting great economies over the hydraulic methods formerly employed, has made possible the use of automatic means of maintaining the thickness constant, a matter of very great importance in many cases. While the direct economies arising from the introduction of electric driving have been very great, its secondary results have been no less important.

In an electrically driven machine room, it is a perfectly simple matter to obtain the power absorbed by each machine and each line of shafting at any time. This, together with the wide range of speed which is possible in electric driving, as compared with that given by cones and belts, has played an important part in recent machine shop development, by enabling the speed and depth of cut to be adapted to the class of work in hand. It has also contributed greatly, by enabling shafting and bearing losses to be easily located and determined, towards the introduction of more efficient bearings, and the elimination of defects in the adjustments of both shafts and bearings.

Some American cement works have recently been successfully equipped throughout with electric driving, in spite of the severe conditions to which cement-making machinery is subject. With such examples as these, and the results achieved in iron and steel works, it would appear difficult to specify any class of factory work to which electric driving could not be applied, though the system to be adopted in any given case must, in order to obtain the most economical results, be determined only after the most careful consideration of every detail of the work required.

❧

The Application of Electricity on the Oil Fields.

By L. GASTER, A.M.I.E.E.

In describing the advantages of, and the progress made during the last few years in, the application of electricity for boring, pumping, and other purposes in the oil fields, the author thinks that a few general facts concerning the extraction and use of petroleum, and the various products obtained therefrom, may serve as a fitting introduction. His remarks are based on a careful examination of conditions existing on the Roumanian and other oil fields. The total amount of oil produced last year from the wells operating throughout the world, is estimated at over 20,000,000 tons, of which more than half was produced from Russia, the remainder coming from America, Galicia, Canada, Roumania, Borneo, etc. The imports of petroleum into the United Kingdom alone last year exceeded 285,000,000 gallons, a quantity far exceeding that of any preceding period. The demand for oil is certainly increasing, and it will be shown later, that in order to increase the output, and to obtain greater safety in the exploitation of the oil fields, electricity will prove the most efficacious and advantageous power agent. The application of oil as a commercial commodity is growing daily, its widest employment at the present time being as liquid fuel. The calorific value of oil residue, as liquid fuel, is on an average over 11,000 calories, which is much higher than that obtained from the best coal. The use of liquid fuel is at present hampered by the price of the oil, and if a heavy demand arose now, it could not be met by reason of the scarcity of the product. The change from coal to liquid fuel could not be effected with advantage on a large scale, unless a constant oil supply at a steady price were forthcoming. In Russia, where oil is cheaper than coal, almost all ships trading on the Caspian Sea or the Volga use liquid fuel with great success, while the Transcaucasian railway between Baku and Batoum has followed the same example. In the United States, liquid fuel is continually growing in popularity, and at present, the South Pacific and the Santa Fé Railway Companies are burning oil on most of their locomotives, the price of coal there working out far higher than that of oil.

In this country the Great Eastern and other railways have experimented with oil fuel, with a view to its general adoption, but so far, progress has been rather slow. The Wallsend Slipway Engineering Co. have employed liquid fuel for marine boilers, and have, with very good results, fitted up a great number of vessels on this system. The Western Railway of France are also using liquid fuel on many of their fast expresses.

The advantages of oil as a fuel are recognised by all experts, and the experience of the past few years should induce power station engineers to provide a system of firing combining both oil and coal as fuels. Too much prominence cannot be given to the disastrous effect on electricity works occasioned by serious strikes, lockouts, etc., in the coal trade. Other uses of oil which may be mentioned *en passant* are, the enrichment of coal gas by oil gas, and the extraction from it of lubricating oils, while its employment for oil engines is too well known to call for detailed comment. The residual coke from the dry distillation of petroleum, or from the recovery products of the waste acids, due to the oil refining, is of value in manufacturing electric light carbons or electrodes for electro-chemical processes. The many applications of petroleum in the engineering world, apart from chemical spheres, where it has considerable vogue, are of sufficient importance to merit the attention of electrical men generally to the chief sources of supply from which so valuable a natural product is drawn. Hitherto, electric power has stimulated the output of almost every industry to which it has been applied, and in this instance, the results of an increased petroleum supply are so far reaching in their influence upon the problems of electricity generation, that the wholesale conversion of the methods adopted to obtain the oil may well receive serious consideration.

With a few notable exceptions, which are on record only since electricity was suggested for the purpose, the extraction of crude oil has been carried on either by hand or steam power. The former method has proved dangerous, chiefly because very primitive devices are employed for maintaining the air supplied to the well. The hand bellows used are quite incapable of guarding against a rush of poisonous gases, which would quickly overpower the workers, and great courage is accordingly needed to work the wells under such conditions. Such wells in Roumania have been bored to a depth of over 650 feet.

Steam has been much used as a power agent, but such great dangers arise from its employment, and so extravagant are the losses due to condensation along the pipes connecting engines and boilers, etc., that it seems remarkable electricity has not been previously introduced. Serious fires have broken out when boilers have been placed near wells which have overflowed, and reached the furnace fires before they could be put out. Enormous damage is quickly done when the conflagration spreads, and naturally the environment forms a ready source for increasing the difficulties of those who essay to quench the flames.

The problem presented to electrical engineers is an exceptionally interesting one. Firstly, ample scope is afforded for producing electricity by burning the crude oil in suitable engines, and thus securing marked economies in generating costs. Secondly, the possibilities as outlined in the first item, may be extended to the supply of power over a wide area of oil fields, from a large central power house, in which gas or steam engines of considerable output might be employed. Many prophets have recently arisen in favour of the high power gas engine, while correlative with such statements is the excellent work of gas engine makers, who have constructed a type of engine for direct coupling to a generator. It is no far cry to the oil vapour engine, of similar design, running with oil gas, purified by some special process.

Again, the value of polyphase currents for operating induction motors, whose sparkless running has marked them out for special favour in fiery mines, etc., lightens considerably the task of "electrifying" the oil fields, from the electrician's point of view. Economical transmission can also be undertaken with the prospect of certain satisfaction at the motor end of the line.

To the owners of oil fields the advantages of electric power must already have been sufficiently obvious. Neither steam, compressed air, or rope transmission affords a satisfactory solution of the problem presented. With the borings alone, the flexibility of electric power is fully exemplified, as the selection of boring places can be undertaken with greater freedom than if some cumbersome method of power were employed. Again neither of the mechanical systems mentioned above is equal to a sudden overload, such as may be imposed by pulling up rods from a well or other exigencies arising. Consequently, such plant needs to be larger than the normal conditions of rating would demand. Electric generators and motors, on the other hand, are equal to a 50% overload on occasions, and it may be noted here that the total motor capacity can be 30% above the station capacity, as the power taken at any one time seldom exceeds two-thirds of the output of the motors.

HAND DUG WELL AT BUSHTENARI.

(To be concluded).

Power Rates in America.

THE National Electric Light Association, in a recent report on prevalent lighting and power rates in America, gives the highest charge for power at 10 cents per unit with liberal discounts, this figure being seldom exceeded. The lowest price touched one cent per unit for 300 h.p. and more, though plants employing water power or cheap fuel sold at two or three cents per unit, after sliding discounts were considered. The next association report will include data as to the cost of fuel in the districts under criticism. Water power stations with overhead systems can charge less for both light and power than can steam plants using underground cables. City prices are accordingly higher unless exceptional conditions prevail.

Longest Power Line in North-Western States.

THE Washington Water Power Co. runs the longest transmission line in the North-Western States. 110 miles separate generator and consumer, much of this distance being over swampy ground, where in winter ice formed round the pole butts, and lifted some out of the holes. Underground cross-pieces overcame this trouble. 60,000 volt Locke insulators and pins are used to carry three No. 2 solid copper wires, which form the transmission lines. Two turbines operating under a head of 70 ft., drive two 2,250 K.W. 4,000 volt, revolving field alternators, the voltage being stepped up to 45,000 or 60,000 by three water cooled transformers. The higher voltage has been experimentally used with success for some time. Six sub-stations are supplied for transforming down the line voltage, and distributing three phase current to induction and synchronous motors used for mining purposes. Four 300 h.p. induction motors, for driving compressors and hoists will be used in two of the mines. The synchronous motors are started direct from the line, through low voltage taps on the transformers.

Wind-Driven Electricity Works.

PROFESSOR LA COUR, who has been studying the above question on behalf of the Danish Government, has been able to overcome the chief drawback to the use of wind power for driving dynamos, and can impart a practically continuous speed to the generator, independently of wind variations. An intermediate shaft, in connection with a balance, is driven by a belt led vertically on to the disc of the shaft, pressure being regulated by weights. The belt then slides on the disc when a pre-determined load is exceeded. A plant of this kind has been in satisfactory operation at Askov, Denmark, for nearly a year, petroleum motors furnishing energy in calm weather. The normal load is 50 ampères at 220 volts, representing 450 incandescent lamps, the rates charged being 50 öre per K.W. hour for lighting and 15 öre for power. Working expenses amounted to 800 kr. per year, and revenue from all sources was 2,800 kr., leaving 2,000 kr. profit on a capital expenditure of 16,000 kr.

Professor La Cour presented these figures at a lecture before the recent Technical and Sanitary Congress, Copenhagen.

Water Power in the "North Country."

MANY interesting water power installations are being erected in the United States, following on careful investigations of experts desirous of developing the water power resources of the country. The Chasm Power Company has installed such a plant for the lighting of Chateaugay, advantage being taken of a fall of water, varying from 60 to 200 feet, in a narrow gorge, an abundant head being secured from a number of lakes feeding the river. The initial equipment comprises one 180 K.W. three-phase generator, supplying power at 2,100 volts, subsequently stepped down to 105 volts for light and power service. 1,000 h.p. is directly available at this spot and 2,000 h.p. is in sight. Supply will also be given to an adjoining town five miles away, the line for this being under construction. Low rates have been fixed in order to develop business, prices being 8s. 4d. a year per 16 candle power lamp for residences, and 12s. 6d. a year for commercial buildings. The motor rates have been fixed at £4 3s. 4d. per h.p. per year.

The Lachine Rapids Power House.

THE power house of the Lachine Rapids Hydraulic and Land Co., Montreal, is 1,000 ft. long by 50 ft. wide, and divided into three generator rooms, each containing four 750 K.W. three phase 5,000 volt generators. As originally designed, the exciters were driven from the generator shafts, but pressure regulation became so difficult that it was deemed advisable to operate the exciters from separate turbines, contained in spaces between the generator rooms. The old switching arrangements also were not conducive to adequate control, as the wheel attendant could not be seen from the galleries. A central controlling position was accordingly selected, and the boards for the 12 machines were assembled upon this new platform, which commanded a view of the entire plant. The switching arrangements provide for the running of all machines in parallel or the sectionizing of the generators in sets corresponding to their respective rooms, electrically operated oil switches being used for separating the bars. Better regulation has been secured by adopting Lombard governors, electrically controlled from the switchboard. Two solenoids are fitted to each governor, and by energising one or the other the speed can be raised or lowered as desired. A fire-proof subway accommodates all cable connections between machines and switchboard, the high tension leads both generator and feeder, being lead covered and paper insulated, for a pressure of 10,000 volts. The exciter cables are separated from the high voltage conductors in every instance. With several other modifications the old plant has been quite brought up-to-date.

Electric Tree Felling.

THE time-honoured axe and power-driven saw are no longer necessary to cut down trees. In the forests of France, electricity has been employed to heat a platinum wire, which is used like a saw, the white heat attained burning through the wood. No dust is produced, and the slight carbonisation preserves the wood at the point of severance. One-eighth of the time is said to be required compared with the old sawing process.

The extraordinary and rapid developments in electric traction call for a special section entirely devoted to this work. The main systems in vogue or projected in every country will be specifically considered. and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

INTRODUCTORY ARTICLE.

By G. W. de TUNZELMANN, B.Sc., M.I.E.E.

In Electric Traction much interesting work has been accomplished during the past year, although the clouds due to ill-considered legislation, which have so long overshadowed our own electrical industry, and especially the traction branch, have not yet been entirely dissipated. Still, we have no reason to blush for our contribution to the general progress, either as regards design or execution. In electric tramway work we had fallen considerably behind other nations, but now that legislative restrictions have been partly removed we are fast making up for lost time. The battle of the overhead trolley against the conduit and surface contact systems still rages in some municipal quarters. The companies are, without exception, faithful adherents of the former, for their object is to earn profit for their shareholders, and the æstheticism which regards the doubling of expenditure a lesser evil than the desecration of the picturesque beauties of Kennington, Peckham, and Camberwell, by the admission of overhead trolley lines, is usually to be found only amongst those who can spend other people's money without serious apprehension of being called to account.

Still, at present there appears to be no reason to apprehend any realisation of the prognostications of the prophets of evil, who so strenuously criticised the engineering features of the South London conduit system. Traction engineers will be inclined to congratulate themselves on the opportunity afforded them of watching the results of a very interesting experiment on an extensive scale.

The municipal authorities of Wolverhampton have made an interesting experiment, though only on a small scale, by adopting a surface contact system. The result has not been all that could be desired, as in addition to increased expenditure, and other troubles which may very possibly be remedied with further experience, the adoption of a system differing from that used in the environs causes an isolation which can hardly prove beneficial.

It is anticipated that the Dolter Surface Contact system may be adopted at Torquay, and few would be found to cavil at incurring an increased expenditure to exclude overhead lines from this very picturesque town, for its strongest adherents would perforce vote it an undesirable addition to the beauties of the landscape.

In heavy railroading we have maintained the lead obtained by the very successful pioneer work of the City and South London Railway, from which American and German engineers may still learn valuable lessons. We have the Central London Railway; and the largest generating units yet designed are in course of construction for the Metropolitan and District Railway power station. Engineers will, before long, have an opportunity of making an interesting comparison between the Sprague-Thomson-Houston Multiple Control system, which is to be employed on these lines, and the Westinghouse Electro-Pneumatic system, which is to be adopted on the London Underground railways.

That certain of our railway companies are taking steps to meet the growing competition from electric tramcars, and cope with heavy suburban traffic, is well exemplified by the action of both the North-Eastern and Lancashire and Yorkshire railways. These companies are equipping respectively, sections of their lines at Newcastle, and between Liverpool and Southport; the last mentioned being now nearing completion, while experimental runs have been made with the trains to be employed on the Tyneside. The operation of these lines, though presenting nothing new to electrical engineers, as far as equipment is concerned, will be watched with considerable interest by railway men, who are now faced with the problem of improving their main line service.

The high speed trials on the Berlin-Zossen line have been followed with the greatest interest. The maximum speed of 131 miles an hour attained in the course of the trials did not appear to be accompanied by any conditions indicative of danger, and the trials showed conclusively the possibility of speeds very much higher than the ordinary maxima on steam lines. Some of the results of observations at speeds more nearly approximating to those of steam driven trains appear to afford strong arguments in favour of the contention that electric driving on main lines would show an economy over steam, as far as new lines are concerned. In the case of existing railways, however, there would still remain the apparently insuperable obstacle of the enormous loss entailed by consigning the present steam locomotives to the scrap heap.

The significant failure of the mono-rail to find financial support, in spite of its Parliamentary powers, is no longer inexplicable in the light of the Zossen experiments, even if the coincidence be regarded in no other way. The system would doubtless be a satisfactory, if expensive, method of utilising the substructure of existing lines for high speed trains, did not the future hold hopes of phenomenal speeds over comparatively straight roads, connecting important towns; all ordinary traffic being, of course, conducted by methods now practically standarised.

Another problem, which continues to attract the attention of many engineers, is that of single phase traction,one of the most interesting of the methods devised being the electropneumatic system of B. J. Arnold which is now being carried out experimentally on a short American line. It is adapted for either monophase or polyphase current. Single-phase methods have also been devised by Finzi, W. B. Potter, Mordey and Jenkin (see page 44), and others.

The effective braking of electric cars is a most important matter, both from the point of view of safety, and from that of increase in schedule speeds. In the course of 1902 some important improvements were effected both in air brakes and magnetic brakes, and a good deal of attention has been called to the matter through the unfortunate accident at Ramsgate in August last. No track brakes were provided in this case, as they should have been. With the continuous current series wound motors usually employed on electric cars, a track brake is essential in hilly districts, and to ensure its being always in working order and ready for use, it should always be employed, as a matter of regular routine, in descending steep gradients. These motors do not, like alternate current motors, exert a braking effect by acting as generators and returning current to the line when the speed exceeds a determined limit. This regenerative action, valuable in the interests both of safety and economy, could easily be obtained with shunt motors, and Mr. J. S. Raworth, who had previously endeavoured, without success, to overcome the difficulties hitherto preventing the use of these motors on electric cars, was induced to make a fresh attempt, on account of accidents from brake failures on the very hilly route of the Devonport and District Tramways. This time he was successful, and shunt motors are now employed on all the cars of this line, and may be expected to come into general use on tramways traversing hilly districts.

Some interesting trials of a method of what is known as tangential traction have been carried out at Charleroi, in Belguim, but details as to costs are not available. The method, due to two Russian engineers, Messrs. Rosenfeld and Zelenay, consists in developing an ordinary induction motor into a plane, distributing the primary along the rails, and placing the secondary on the car. In order to lessen the enormous cost involved in a continuous stator, or primary, extending the whole length of the line, stator sections are substituted for a continuous stator, and these are successively made alive while the car or train is passing over them, by means of switches actuated by the train. This forms the weakest point in the system, which has the great advantage of not requiring the supply of current to the car. A German engineer has still more recently devised a system in which the primary is placed on the car, an iron rail fixed on the track forming the secondary. This would be very much less costly and would obviate the necessity of make and break switches actuated by the train. It would, however, sacrifice the advantage of no current supply to the car being necessary.

A good many electric and electro-pneumatic methods of train signalling have been devised, and in America these are beginning to be regarded by railway men with considerable favour.

Reliable systems are now available in which the line is divided up into sections corresponding to those of the block system of signalling, and by automatically acting electric devices, a train can be prevented from entering a section on which another train is running which has been damaged in any manner to the extent of breaking the continuity of the rails or contorting them to a dangerous extent. In such a case, if the engine-driver attempted to enter the section, the brakes would be put on by means beyond his control, and at the same time the supply of power would be shut off. On a steam railway this is effected by an electro-magnetic device for shutting off steam, while on an electric railway the supply of current to the motors would be stopped. These devices would only come into action in case of the driver not receiving, or neglecting to obey, the indications of the signals. In case of a breakdown of the electric control system, the driver would be instantly apprised of the fact by some such means as the extinction of a light on the engine or car, the ringing of a bell, or some equally noticeable warning.

Another method, which is stated to be attracting favourable attention in America, is one in which the control is not automatic, but which enables the trains over any system of lines to be controlled by an official stationed at the controlling centre. In this system a complete small scale model of the system of lines to be controlled is placed within the view of the official in charge at the controlling station, miniature trains running over the model system simultaneously with the ordinary trains.

The model system is provided with a miniature system of signals forming the exact counterpart of those in actual use, so that the controller can see at once if a driver runs past a danger signal. Moreover, no collision between trains can take place without a corresponding one between the model counterparts. In any case of danger the controller could, by simply pressing a button, put on the brakes of any train on the system and shut off the supply of power.

Electrical canal haulage is now coming into extensive use in America and on the Continent, and it is difficult to see why our own very elaborate system of canals, now comparatively little used, should not receive a new lease of life by the use of electrically transmitted power.

A considerable amount of interest has been excited by the nickel-iron accumulator which T. A. Edison is placing on the market, and strong claims have been made regarding its suitability for use on electrically driven vehicles. The tests made by Mr. Hibbert, and those made at the Central Electrical Laboratory in Paris, show that it will stand a high rate of discharge without deterioration. But this is not of very great advantage for automobile work. Moreover, the efficiency is very low compared with that of lead batteries, except at very low rates of discharge. There appears to be promise of exceptionally high durability, and the cells may be allowed to stand for some time without recharging without permanent injury. As regards output in comparison with weight or size, it will only approach that of a good lead battery when the discharge is carried out over a much larger range of voltage than with lead batteries. The cells will stand this with impunity, but it would be a very serious disadvantage for automobile work, as besides necessitating the use of special series parallel grouping arrangements, the large range of voltage would require the use of additional cells, unless the speed is to gradually diminish during a run of any length.

CANAL HAULAGE.

As remarked in the opening address to this section, canal haulage by electric tractors, electric tugs or any electrical means, has not found favour in this country, although we possess a lengthy mileage of canals, excellently situated for transporting goods between important centres. On the Continent, they have the canals and are not afraid to experiment with them. In the United States also some interesting work has been carried out. Some 42 miles of canal between Cincinnati and Middletown is now operated by hauling locomotives running on a track on the canal bank.

Power is primarily supplied at 4,200 volts, 3 phase, 60 cycles, to a motor generator station, which delivers current at 390 volts to the local section of trolley line, and in addition feeds four sub-stations with 33,000 volts, 25 cycle three phase current. These in turn deliver power at 1,170 volts (still three phase) to the trolley lines, two in number, the rails acting as the third conductor. On the locomotive, another transformation takes place to 390 volts, at which pressure the motors are operated. On the Erie, Oswego and Champlan Canals, which have competed with railroads till now by mule haulage and 250 ton barges, experiments dating as far back as 1893 were conducted with electric tugs and tractors. Only recently, however, have they afforded any practical result. A mono rail has been adopted, on which runs a special locomotive driven by two 40 h.p. direct current motors through double reduction gearing 40 to 1. A single trolley furnishes the requisite power from an overhead line. The tractor is iron-clad to protect it from the weather, though all working parts are readily accessible. Special arrangements are made to keep the motor steady and increase the tractive effect, a draw-bar pull of 30,000 lbs. being obtained. 2,700 ft. of track has been laid and tests conducted with two 600 ton barges showed a speed up to 4½ miles an hour, with but slight wave motion in the canal. Estimates given for the equipment of the Erie canal, 352 miles long, with the system, amounted to $7,040,000, including 300 tractors of 80 h.p. each. Seven months' total expenses were set at $1,310,940, and a gross revenue of $5,400,000 from hauling 10,800,000 tons at 50 cents per ton, thus leaving nett earnings of $4,089,060.

◆

An annual subscription to *The Electrical Magazine*, booked now, carries with it special advantages. See other announcements.

ELECTRIC TRACTION FOR RAILWAYS.

I.—Some Considerations and a Warning.

By W. M. MORDEY, M.I.E.E.

The writer gladly accedes to the request that he should write something for the first number of *The Electrical Magazine* on the subject of the coming application of electricity for driving trains on main line railways, or on considerable portions of such lines—a subject to which, at the present time, much attention is being given.

The next few years will probably see the beginning of this work on most of our railways. Much will depend on the manner of these beginnings. The time is a critical one. Electricity has been applied successfully to a good many short and busy lines, and there is a disposition to believe that for the working of long lines it is only necessary to go on as we have begun—gradually to increase the length of line equipped on the present system, and so perhaps ultimately work the whole of a main railway electrically, and perhaps inter-connect different railways—very much, in fact, as is already being done with electric tramways.

This expectation is certainly doomed to disappointment. The present method — as used for example, on the Central London, on the City and South London, on the Liverpool Overhead Railways, and as being put down on "The Underground," on certain lines about Newcastle and about Liverpool—is quite certainly not suited to form the *nucleus* from which a general and comprehensive main line electric railway system can grow. However suitable such a method may be for short and busy lines—and it is not by any means ideal even for such conditions — it is commercially and technically unsuitable for long ones. The present method is very well adapted and will probably continue to be used for tramways, but it is lacking in several essentials for railways. If used for these it is certain to be replaced before very long by something more suitable. The cost of such replacement will go a long way to counter-balance any temporary advantages which may be obtained.

Various causes may lead to premature action. One is the very natural desire of the great railways to make some immediate effort to check the loss of suburban traffic or to increase the carrying capacity of congested routes; another is the equally natural desire of large manufacturing concerns to sell the kind of plant they are at the moment prepared to turn out; a third cause is the desire not to be left behind by other countries—a desire to do something at once, if only to show that we are not entirely asleep and devoid of enterprise. If immediate action is unavoidable it is none the less to be regretted. Fortunately, however, for the material stability of this country, we "make haste slowly," especially over new things. Sometimes we lose a little by this temporarily, but in the long run we gain. The reasons put forward for our supposed backwardness are usually very unfavourable to the British character and to British enterprise. It would be much truer to say that we are very fond of telling other people we are beaten when we are not, than — as Napoleon said of us — that we do not know when we are beaten! It is a British quality this—a sort of "divine discontent" with the supposed imperfections of our fellow-countrymen. At least it tends to caution and prudence.

We need be under no alarm as to our enterprise in electric railway matters. We started running the City & South London Electric Railway in 1890, and followed with the Liverpool Overhead Electric Railway. These two railways were working years before any practical electric railway was working in America or elsewhere; and when America did begin, it was by copying those two lines, which are to-day, in spite of their old plant, giving results that are as good, if not better than any electric railway of them all. And yet such is the character of the two peoples that every American, and most Englishmen, believe that electric railways were introduced into this country from America.

But now great caution is necessary, if we are to avoid serious losses. There are two systems of electric railway working now in use, both of which have very serious inherent drawbacks for anything like general application to main line work. Those two systems are, first, the direct-current system already referred to, with a live rail, or perhaps two live rails, on the track ; and, second, the three-phase alternate-current system with two overhead conductors. The first of these is in extensive use here, in America, in Italy, and elsewhere. Of the second we have no example here, nor is there any in America, but it may be seen in various modifications in a good many places on the Continent—in the Valtellina near the Lake of Como, on the Engelburg Railway in Switzerland, on the line between Burgdorf and Thun on the Swiss State railways, on the Jungfrau mountain railway, and elsewhere—and most interesting of all, on the Berlin-Zossen experimental railway, where the very interesting and important high speed trials have been made. From all this work we know that there is no serious engineering difficulty in driving trains electrically over any given line and at any required speed. The difficulty is to do it on a comprehensive system with low enough capital and working costs to make it worth while—to do it on a plan that contains the essentials necessary to meet all the various conditions of practical working—of gradual growth of the system on a uniform basis, of safety and simplicity of the live line, with full regard to the practical requirements of track maintenance, with quick or with slow speeds, and complete control of speed under all conditions, with quick or slow starting and stopping, and with economy of energy at all stages.

The main result of experience with the two systems in present use is to prove that neither of them, nor any combination of the two of them, contains the full solution of this problem. But the problem is in process of being satisfactorily solved, and such a solution will certainly be reached within the next year or two by the development of one-phase alternate-current methods.

Before referring to some of the work now being done in this direction, it may be well to give the reasons for the views expressed above. Let us see what are the essential requirements, and in what respect the present direct current or multi-phase alternate-current systems fail to realise those essentials.

(*a*) To transmit the large amounts of energy required over long distances, a very high electro-motive force must be used.

(*b*) The transforming sub-stations along the line must be few in number and must contain no moving machinery. There must be no need for constant attendance; the transforming apparatus must not be costly and must not be wasteful of energy, especially it must be economical of energy when the trains are infrequent.

(*c*) It must be easy to work the motors at different pressures, so as to use a lower pressure in tunnels and on town lines than in the open country.

(*d*) A high pressure system being necessary, the conductors must be overhead for safety and to enable track maintenance to be carried on easily.

(*e*) The overhead system must be simple. Great practical advantages will result if one overhead conductor will do.

(*f*) The overhead system must be capable of unlimited extension, so as to allow of natural growth of a long line or of a net work of short lines.

(*g*) It must be possible to run at any required speed up to full-speed—to vary speed as required, and to make up lost time.

(*h*) It is desirable that, when going down hill or when stopping, the energy of the train should be returned to the line to help other trains and to economise power, instead of wasting it in the brake blocks.*

To show how important this last mentioned point may be, especially on lines with many stops, where prompt starting and stopping are essential, the Liverpool Overhead Railway may be instanced.

---

* Further details and explanations than it is possible to give in this article will be found in a paper by the author and Mr. B. M. Jenkin, read before the Institute of Civil Engineers in February, 1902. Since the reading of that paper the views then expressed have begun to receive practical illustration, several prominent engineering concerns being engaged on the development of one-phase methods.

From an examination of the performance of the trains on that line, the author finds that, of the total energy supplied to the trains, about one-half is wasted in heating the brakes, a fourth is wasted in heating resistances, and a fourth is usefully spent in driving the trains. In other words, the generating station has to produce, and the lines have to transmit, four times as much energy as is usefully employed by the trains. The Liverpool Overhead Railway is a very interesting and excellent example of direct current railway working, but these figures show that it falls far below the standard of electrical efficiency commonly met with in other kinds of electrical work.

The requirements enumerated above taken together effectually exclude both the direct current and the three phase alternate current systems for railway work on a large scale, but they can be met by the one phase system. Let us therefore wait for —and if possible assist—the development of some method that has the elements of success inherent in it, rather than go on applying, as a makeshift, methods lacking those essential elements.

All we want is involved in the one-phase principle, and is being rapidly evolved from it. Meantime there is need for prudence and foresight. Except in a very narrow sense this does not mean any real delay—it means that what is done in the near future should not require undoing soon afterwards.

W. M. Mordey

(To be continued).

Next month Mr. Mordey will deal more specifically with this question, and his article, which will be found of exceptional interest to all railway men and electrical engineers, will be illustrated by a number of original photos.—Ed. E. M.

◆

The Electrical Magazine will form a concise medium of reference to electrical engineers, and it behoves all connected with the science and practice of electricity to secure the succeeding numbers, as they will contain articles of exceptional interest and value to every member of the profession. While it appeals alike to professor and physicist, it equally treats of matters within the grasp of the artisan. Each will find sections devoted to his special domain of thought and action, while the pages outside these particular limits will bear close inspection, as a guide to the current state of electrical affairs in all parts of the world.

Prospective Changes in Railway Signalling.

By J. PIGG, A.M.I.E.E.

Electricity has been termed the handmaid of railways in its earliest adaptation for commercial purposes—the electric telegraph. The potential developments of electricity in the service of railways are at present so vast as to indicate that electricity is likely to be more of a "general" in the near future. Railway companies were the first commercial users of electricity, and modern developments of the adaptation of the electric telegraph, by Cooke and Wheatstone, to the signalling of trains, in 1839, have had enormous, if indirect, influence in perfecting the present means of transport.

For many years railway signalling in this country has undergone comparatively little change. In its general character it is the same as when the principal companies commenced to install it upon their lines, in the early seventies. The provision of visual signals for the guidance of drivers, the assemblage of the means of actuating the points and signals, and their interlocking to prevent fouling operations from being undertaken, together with the electrical apparatus for perfecting the necessary arrangements for the passage of trains in due order of precedence, and with the local interval of space—all under direct manual control and operation, constitute the chief points in the "Block" system of railway signalling. On the whole, the English system of signalling has worked well, from the point of view of the safety of those who travel. Notwithstanding the intricate maze of lines, and the vast volume and the varied character of the traffic handled daily, the railway companies of this country hold the highest position for comparative freedom from accident. Much of this magnificent result is due to the elaborate organisation of the block system, which, in conjunction with its auxiliaries, the telegraph and the telephone, has also been equally effective in promoting that adherence to the time table, so necessary to the business of the country. The systematic division of lines into sections, independently controlled, the provision of simple, yet efficient equipment, with elaborate precaution against misadventure, the promulgation of closely reasoned regulations for the guidance of the executive, and the careful selection of the staff, have resulted in a system, which, whilst undoubtedly the cause of huge expenditure, has furnished the railway companies with practically the only means possible for ensuring the safety and speedy transit of their traffic.

Notwithstanding the excellent results obtained, however, we do not enjoy complete immunity from accident. Human control provides the reasoning power, which can divert the consequences of error, and, in so far as this is accomplished, human control is justified. Human control, however, is not infallible, and by its lapses from vigilance has, time and again, been the cause of accident. Even the independent control of the two signalmen, and the vigilance of both driver and firemen do not suffice to avert disaster in all cases. This is, chiefly due to the absence of inter-dependence of action on the parts of the persons concerned. The particular forms of lapse most likely to result in accident are perfectly well-known, and have led to the devising of apparatus, which seeks to impose checks upon the actions of the signalmen, and limit his actions to a cycle, by making the various operations for the progress of a train dependent upon the completion of the previous cycle of operations. Here, then, is that inter-dependence—controllable by the train itself—the want of which, as has been seen, has led to accident in the ordinary system. Such systems are known as the " Lock and Block," and at first sight they seem to provide all the checks necessary for safe working; and it may be said that they undoubtedly furnish efficient checks on the signalman when working on the cycle imposed by the design of the apparatus. Notwithstanding strenuous advocacy of these systems they have made comparatively little progress in this country. One reason for this is the great difficulty in operating traffic in an unvarying cycle, which has necessitated some means of release, other than that part of the cycle arranged for the purpose; and the improper use of the auxiliary release has sometimes led to serious disaster. Another reason is that all forms of lock and block are apparently designed under the impression that the signalman only is to be checked, whilst experience proves that the driver is equally liable to error. lock and block systems offer no check on inadvertent action or neglect on the part of the driver. Still another, and most important reason, is the greater expense of lock and block systems, both for installation and maintenance. The electrical apparatus for signalling by the ordinary system is of the simplest possible description, and consists chiefly of the ordinary single-needle telegraph instrument, as the indicator of the line condition from time to time, and the direct action bell for the exchange of signals by code. Lock and block instruments are necessarily more expensive, in consequence of the greater demands upon them, and the auxiliary apparatus for providing the necessary train control naturally involves further expense. When, as has been seen, notwithstanding the additional expense incurred, such installations do not meet all the conditions obtaining on a railway, and that the automatic control obtained by normal working has to be set aside on the signalman's judgment—faulty exercise of which the system is designed to correct—the small progress made in installing such apparatus is no longer inexplicable.

The lock and block system is the only variation of the original methods of block signalling that has, until quite recent years, obtained any footing. The prospects of change are now much greater, and electricity is still the medium by which the changes are to be effected. Amongst the systems of signalling now being experimented with, are those employing power for the operation of points and signals, instead of the manual labour hitherto invariably used. Examples of these are to be found at Crewe, on the London and North Western Railway, and at York, on the North Eastern Railway, at both of which places the electric system of Webb and Thompson is in use. Other installations of power signalling are to be found at Bishopsgate Street, on the Great Eastern Railway, and at Tyne Dock, on the North Eastern Railway, where the Westinghouse electro-pneumatic system is employed.

In another department we find experiments being made with American automatic systems, designed to dispense with human control, as at Grately, on the London and South Western Railway, and as now being installed between Alne and Thirsk, on the North Eastern Railway. In another direction we have an experiment under weigh for giving signals directly upon the engine by electrical means, as at Woodhead Tunnel, on the Great Central Railway. In still another direction we have suggestions for dispensing with the time-honoured semaphore arm and all the mechanism necessary for its operation, and the use of electric lamps, which would be operated by simple switches, at all times of the day. In addition, electricity is likely to find further use for lighting signals in preference to gas. Experiments have been in progress for a considerable time to ascertain the suitability of the incandescent electric lamp for lighting signals, and, so far, any fears that its fragile character would be a bar to its employment are not justified, the light being thoroughly reliable. Moreover, 5 c.p. lamps, which are about equal to the light given by gas, for standard pressures, are now available. The load factor for such lamps would be of a most satisfactory character from the supply point of view—an average use of about twelve hours per day throughout the year—and should be economical to the companies at a higher cost than gas even, owing to the economy of attendance for lighting and extinguishing lamps, cleaning, etc., and the reduction of the actual times of use for many of the lamps.

Many of the experiments enumerated involve radical departures from present practice, and their financial results have, no doubt, been closely examined by those responsible for their recommendation, as well as the technical and operative aspects. The principal point to be determined from actual use is whether the human control of traffic, which has, hitherto, notwithstanding numerous failures, been the chief characteristic of signalling systems in this country, is so indispensable as has, tacitly at any rate, been assumed. In view of this, the experiments with the automatic systems at Grately, and between Alne and Thirsk, will be watched with keen interest. There are numerous places where such systems seem perfectly applicable, but owing to want of the principle of selection, automatic systems can never be made adaptable to the working of junctions, excepting during the periods when the branch, or branches, converging upon the main line have ceased working. A glance at a railway map of the country will show what an important effect this will have on the prospects before automatic signalling here. The chief characteristic of English traffic is the comparatively short average distance over which the bulk of it is carried, in consequence of the proximity of manufacturing towns, or districts, to each other and their ports. Hence, the distances between junctions where human control is indispensable are very short, and automatic signalling must be confined to the sections between the junctions.

If we carefully consider track circuit systems of automatic signalling, such as are beginning to be used, we find that they offer material advantages over the present systems if circumstances admit of extensive use. Whilst involving but slight difference from present practice from the driver's point of view, they obviate the necessity for providing the most expensive parts of the present equipment. The building, frame, interlocking between points and signal levers, the mechanical connections between the levers and points and signals operated, the electrical signalling equipment and lastly, the controller, are all dispensed with. In their place, motive power at each signal, the preparation of the road-bed, the insulating of the sections, the bonding of the rails, the provision of track relays and batteries, and such special apparatus as the character of the line demands are all necessary. In addition to these requirements, since the essence of the track circuit is its sensibility to the presence of any vehicle in a section, the stock passing over the line must be such that all vehicles provide a metallic connection between the treads of any pairs of wheels on the same axle. Hence, stock with Manson wheels must be specially altered to comply with the conditions for running over such sections.

It has been urged that displacing the signalman does not necessarily dispense with human aid to the full extent of the displacement, as such systems must necessarily involve special labour for maintenance, and that the effect is a mere removal of human labour from one sphere to another. This, of course, is only a short-sighted view of the subject, engendered by consideration of isolated installations. Even if there was no saving in labour obtained, which is an impossible supposition, the change of system has the important effect of completely changing the labour employed to such a character as precludes the possibility of danger from accident through neglect, since neglect of maintenance, under such a system, does not *per se* involve more than delay.

The absence of human control of the signalling throws greater responsibility on the drivers of trains for observation of the signals exhibited for their guidance, since there is no other check to prevent the consequences of error on the part of drivers, as at present. Under certain conditions of weather the driver's position is most onerous in consequence of the difficulty in seeing the signals in the usual way, and railway companies have had to provide supplementary signalling—fog signalling—to meet such conditions. Fog signalling to a large extent is brought into use whenever the signalman considers it necessary. There is nothing to prevent this being done by other members of the local staff where an automatic system is in use, but we find that some form of apparatus for indicating the position of the signals upon the engine directly is recommended. There are many systems available for this purpose, besides the Miller system now on trial at Woodhead Tunnel. Some of these are purely mechanical, such as that of Mr. Raven, of the North Eastern Railway, and a considerable number of these are already in use. Others are purely electrical, such as Mr. W. S. Boult's system of signalling without contact, whilst others, again are partly mechanical and partly electrical, such as that of Mr. Brierley, in which the electrical circuits on the engine are brought into operation by the impact of a swinging lever on an obstruction provided for the purpose on the line.

Another difference in practice introduced by automatic systems is the procedure to be adopted when a train comes to a stand at a signal which is at "danger." Under the present system a train would not be taken past such a signal unless authorised by the signalman's use of the signals which, on occasion, supersede the fixed signals, such as hand, flag or lamp signals. With the automatic signals the signalman does not exist, and since a "danger" signal may be the result of a defect in the apparatus as well as from the presence of a train in the section controlled by the signal, it becomes necessary to provide a rule which shall authorise a driver to proceed cautiously to the next signal in advance, after a wait over a period of time which should, under ordinary circumstances, suffice to clear the apparently blocked section. Hence on a railway under a mixed system of automatic and manually controlled signals, the necessity exists for plainly indicating the different character of the signals, so that drivers may act accordingly. Under the arrangements now being carried out, the difference in the appearance of the new signals from standard practice in this country is sufficient generally to indicate the different character of the signals.

Automatic signalling also necessitates the operation of switches to sidings off the main line by the train staff, or the station staff, if a station exists there, for trains leaving or returning to the main line. Whilst the ordinary arrangements prevent other trains coming to that point, except at caution after the time stop, it necessarily follows that such operations as returning to the main line must be undertaken without such full knowledge of the positions of other important trains requiring to pass that point as is now obtained by the signalman by telegraph or telephone. Special arrangements can, of course, be made to warn the train staff of the presence of trains one, two or three sections in the rear, but they do not necessarily indicate the character of such traffic, or whether it should be allowed to pass or may wait its turn.

A prominent characteristic of the signalling in this country at present is its practical uniformity throughout the whole of the lines in the kingdom. The adoption of the Clearing House code a few years ago rendered the method of signalling, notwithstanding slight differences in the character of the apparatus employed, uniform on all railways. There are good reasons for preserving uniformity as far as possible, but it is evident that, if automatic systems are brought into use, uniformity cannot be maintained. No doubt this aspect of the case has also been carefully considered, since we find the Board of Trade agreeing to the experimental use of such systems.

Automatic systems, such as have been considered, can never become predominant under the present conditions of service in this country, and can only be employed in places such as have already been indicated. It is, moreover, questionable whether their employment has not been considered at too late a period to prevent extensive use being made of them. The wide-spread conviction that railways are on the eve of vast changes in their methods of operation, owing to the successful application of electricity to transport, suggests that other methods of control of trains may come into vogue with the new conditions. Automatic *control* of the power necessary for the movement of trains is in all respects more effective than manual or even automatic *direction*.

AUTOMATIC SIGNALLING . . ON THE DISTRICT RAILWAY.

In view of Mr. Piggs' interesting article, we give here some particulars from the *Engineer* relative to automatic signalling installed on the District Railway, London, the first system of its kind in this country and the second in the world, of an electric railway automatically signalled by means of track circuits.

The system has been applied on a section of line which extends from Hanger-lane Junction to South Harrow, worked electrically by the District Railway for some months past. The length is about five miles of double track, divided into block sections, varying from 1,400 ft. to about 3,500 ft. There are both positive and negative insulated traction rails; the running rails being "dead."

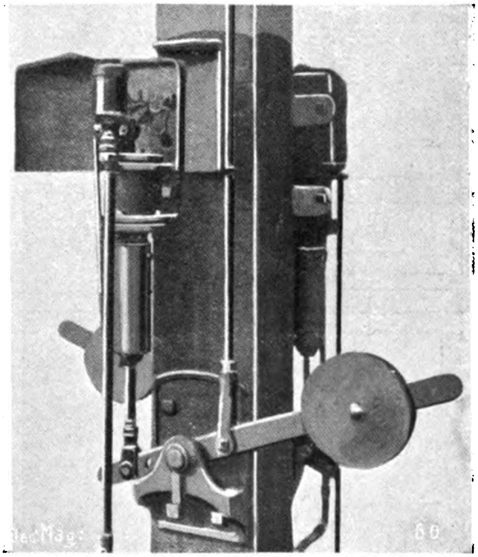


Fig. 1.

The space between stations is generally divided into two blocks, a "starting" and a "berth" block, and the signalling is on the "normal clear" principle.

The Westinghouse electro-pneumatic signal motors were fitted to the operating rods of the mechanical arms of the signals themselves. These motors (see Fig. 1) are enclosed in strong and simple cast iron casings, and they are controlled by small pin valves worked by electro-magnets in the local signal circuit. Signal cabins are required only at each end of the branch or where there is a cross-over road; in the latter case they are normally closed, being opened only when required.

An automatic stop prevents trains from over-running home signals. This consists of an iron arm between the track rails, actuated by a compressed air motor acting in unison with the adjoining signal motor. When the signal goes to "danger" this arm is elevated to a position in which it engages with a cock on the air brake system of the train ; thus the brakes are instantly and automatically applied if, for any reason, the driver should run past the signal.

The principles of the system may be best understood by reference to the diagram, Fig. 2. One of the track rails is electrically continuous throughout the whole length of the plant, and constitutes the positive conductor from generator to individual track sections. The other rail is cut up into block sections by special rail joints insulated with fibre. All uninsulated rail joints are bonded to ensure electrical continuity. Power for the operation of the system is generated at 110 volts pressure by motor generators, the negative terminals of which are connected to an insulated negative running the entire length of the system. This main is connected to each section of the sectionalised track rail at a point near the latter end of the block, *i.e.*, the end at which the train leaves, as distinct from that at which it enters. There is, then, a potential difference of approximately 100 volts between the continuous—positive—rail and the insulated negative main.

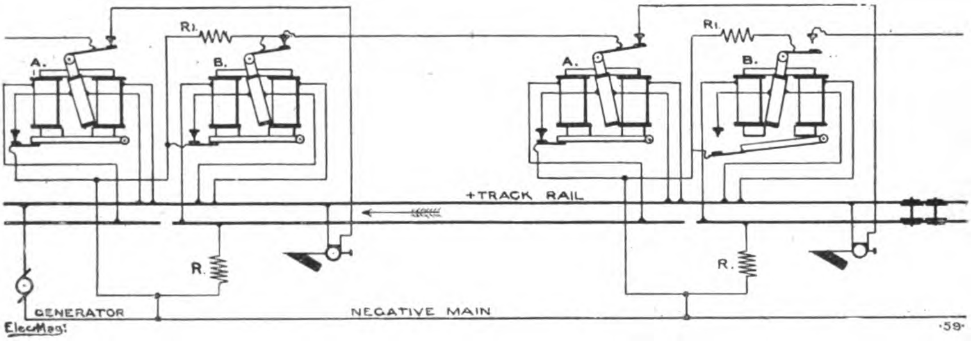


Fig. 2.

Resistances are interposed in the connections between the negative main and the sectionalised rail which reduce the potential difference between the rails to, in the present instance, from 3 to 6 volts, according to the length of the block and various local conditions.

The loss in the continuous track rail may generally be neglected on account of its large section. Another circumstance directly affecting this track potential is the variation of the resistance of road bed according to weather conditions. Broken stone forms much the best ballast from an electrical point of view, and cinders the worst. Though on several recent occasions the track rails on this system have been flooded, the operation of the signals has been in no wise interrupted

Fig. 2 is a diagram of the relay and signal magnet circuits for a single block. The track coils (see Fig. 2) of the relays are permanently connected across the rails at the relay end of the block. Between the pole pieces a polarised armature, suspended from a pivot, bears a winding of considerable resistance, connected between the positive rail and the negative main through a contact—operated by the track coil armature—which is closed when the track coils are energised. To the polarised armature is rigidly connected an arm, actuating a contact which opens or closes the local circuit controlling the signal motors. The operation of the relays is then as follows :—When a difference of potential exists in the normal direction between the rails, *i.e.*, when no train is on the block, the relay track coils are excited and draw up the armature which closes the circuit through the polarised armature. The polarised armature is then attracted to one of the poles of the relay, and, swinging over, closes the contact in the local signal circuit.

There are two relays in each block, one at each end ; these are duplicates and operate normally in a precisely similar manner, each working a contact in the local signal circuit. These contacts are in series, as shown clearly in Fig. 2—relays A. & B.—and unless they are both closed no current can flow through the signal magnet, and the signal will therefore remain at "danger" by gravity.

The position of the apparatus when the block is empty has been indicated above ; both relays energised, the local signal circuit closed, and the electro-magnetic valve operating the pneumatic signal motor consequently open, admitting compressed air to the motor, which holds the signal arm "off." As soon as a train enters the block the relays are short-circuited by the car axles and thereby de-energised, permitting their armature to drop, thus breaking the circuit through the polarised armature coils. The polarised armatures then swing back from their position in contact with one of the track-coil pole pieces, and in doing so break the signal circuit at two points in series. The electro-magnet operating the admission and exhaust valves of the pneumatic signal motor is de-energised, and the exhaust is opened, permitting the signal to return to "danger" by gravity. It is, of course, a canon of successful automatic signalling that any interfering influence must, if it has any effect at all, cause the signal arms to go to "danger" and not bring them "off."

The air pressure used is about 70 lbs. per square inch, which enables contact motors to be used for signals, points, stops, etc. The piping is compact, the electrical wires few and small, and the alterations to the track of a trifling nature. The system is applicable where track return is used with either third rail or overhead trolley wire.

LIGHTING and Heating

Under this heading the development of lighting and heating by electricity will receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., will be comprehensively and impartially described and illustrated.

INTRODUCTORY ADDRESS.

By W. H. STORY, M.A.

WHEN we begin to analyse the progress in electrical work of which we boast, we have to look a little below the surface to find out what has actually been done that constitutes an advance. It is hardly too much to say that since the days when Faraday conducted his experiments, no electrical discovery of fundamental importance to the commercial world has been made. Successive electrical generations have only made the discovery that nothing remained for them but the working out of detail. In fact, to our limited vision, it seems scarcely possible that anyone will ever have the satisfaction of doing as much for the commercial aspects of electrical progress as was done by Faraday. But even if the present generation has contributed nothing but detail work, the work has not been in vain. The main thing which strikes us on looking back over the last fifteen or twenty years is the fact that, electrically speaking, things have grown bigger: our machines are bigger, there are millions of incandescent lamps in use, whereas then there were only a few thousands. But the fact remains that our machines are the same in principle now as then; that the incandescent lamp has actually degenerated—if we are to believe the pessimists, and as for actual novelty, beyond the novelty of vastness, there is not much to show. It is everywhere development that we see, development of ideas known to our fathers.

It has been said that any fool can make an invention, but it takes a wise man to work it out. Detail is in fact everything, and it is in the working out of the thing down to the minutest point that success lies. Probably in no sphere of activity is this more certain than in matters of electric lighting. It has been known almost from time immemorial that if a piece of carbon were to be heated in a vacuum, it would give out light, and would not burn away. This is the general broad principle on which the possibility of the incandescent lamp rests. Still, knowing this general principle, as everybody did, it took years and years of hard work before anything at all practical in the shape of an incandescent lamp was evolved, and the difficulty of the problem we seem scarcely able to perceive, now that we are provided with a solution. Inventors, however, soon saw that it was not merely a filament of carbon which was necessary for the lamp, but a filament prepared in some special and undiscovered way. Any ordinary carbon filament had no mechanical strength; it broke while being carried across the room. Even when this fault was overlooked, it was found to have no electrical resistance, and its life was measured in seconds rather than in minutes. The complexity of the problem is now a matter of ancient history; the simplicity of the solution is evidenced by the fact that the product of those years of struggle has held almost undisputed sway in its own sphere ever since.

But there are now signs that its rights are likely to be challenged, and the past history of the challenger furnishes us with yet another object lesson, showing that matters of detail must be worked out before commercial success is possible. When Professor Nernst made his original experiments, he probably forgot that we live in an age when we are accustomed to press buttons and find the rest done for us. He doubtless thought he should have no difficulty in persuading the world to light his lamps with a match in the way that we have been accustomed to light the gas. As for any difficulty in making the filament, it was obvious there was none. His views were shared by the various persons to whom he assigned his patent rights; they only regretted the terrible depression that would fall on shareholders in electric companies when it was found that a new lamp had arrived which only required half the current of the old ones. It was thought probable that the entire electrical industry would be dislocated. The various concessionaires have since become sadder and wiser men. Some have altogether given up the attempt to make the lamps; others seem on the point of making a real start after an enormous expenditure of time and money. The outer world, for the most part, has not so much as heard of the Nernst lamp. Here again the history of the invention has been very similar to that of the incandescent lamp. It has been found that it is extremely difficult to make the filament for the Nernst lamp, involving as it does several complicated chemical problems in a field of chemistry that has been none too fully explored. As an instance of the peculiarities of the filament, we have the fact that some say it is easy to make the lamps for continuous current, but practically impossible to make them last on alternate current; others say exactly the reverse.

The development of the Nernst lamp has indeed been a long struggle with the forces of nature; not perhaps longer than was the case with the incandescent lamp, but not the less severe. In the case of the carbon filament, a large number of isolated workers had the problem in hand; each probably attracted more by the scientific aspect of the matter than by the very tangible prospect of any material gain. Then dynamos or dynamo-electric machines, or whatever they ought to be called in these days of litigation, were little more than toys, driven by belts as fast as was humanly possible. A large number of these toys could have been put in a room, and there seemed as little of mechanical finality about their appearance as was possible. If one of them went without attention for a few days, it was looked upon as a direct favour of the gods; if they went wrong, nobody could be to blame. Under such conditions, each worker had to find his own resources, and it was not as easy then as now to raise money in the City for purposes that were not then properly understood. Probably, if one were to try nowadays to raise money for the development of a promising invention relating to perpetual motion, the task would not be more difficult than was the attempt to subsidise the lonely inventor of the carbon filament. With the Nernst lamp things have been very different Here it is true the invention started on rather different ground. A lamp had actually been made to burn; it had all the appearance of being ready for the market; at any rate, the least sanguine thought it could at most be a matter of a few months' work to put the thing on its legs. And yet four years have been none too many for the work; thousands and thousands of pounds have been sunk—by some, without result; by others, with the promise of results to come. The amount of hard work which has been put into the lamp would probably stagger us; it is sufficient to say that two of the largest electrical firms in Germany and America have devoted their almost boundless resources to the task, and now appear to be on the point of emerging triumphant.

The progress, therefore, is sure and sound; it is not so much a progress in the discovery of new principles; rather, is it a development of what has already been done. Even in the Nernst lamp, which strikes us with all the force of a novelty, it is known that the patent was not accepted by the German Patent Office without the usual objections. Among others, it is pointed out that Jablochkoff used kaolin in some of the lamps which he constructed, well knowing that when this was heated to a certain temperature it became a conductor. This fact does not seem foreign to the main idea of Nernst, though he no more considered himself to be working on the lines of Jablochkoff than he thought he was developing the incandescent lamp. Still there was nothing essentially new in the idea that non-conductors could be made into conductors by submitting them to high temperature. Possibly, if one unearthed the literature of the subject, it would be found that others had already done work that bordered closely on that done by Nernst. But whereas in this case, the details and ideas were such that practical application could be made, the efforts of predecessors, if such existed, have not survived in a fruitful form. Ideas are to be had in abundance by anybody who has the time to travel to the Patent Office. However, that man is probably wise who thinks that the time occupied by the journey might be more profitably employed by a little work in his laboratory.

❧

Readers of *The Electrical Magazine* will have the inestimable privilege and advantage of finding the whole of their electrical news within the compass of a single journal, instead of having to seek it out in fragments scattered over an endless list of publications in several languages.

THE BREMER ARC LAMP.

This lamp seems likely to make a stir in the arc lighting world. There are, moreover, signs that it will not escape the fate of the successful invention, and that its imitators will be numerous. Whether it constitutes anything in the shape of a master patent, time alone can show. Ingenuity is being displayed in connection with this matter by various persons in various ways. The ingenuity of inventors from the electrical and mechanical points of view is great, but legal ingenuity is often quite as admirable. There seems every likelihood that legal ingenuity will play a large part in connection with these arc lamps. Briefly put, it appears now to be known that, under certain conditions, various substances can be mixed or incorporated with the carbon used in the manufacture of the arc electrodes with the object of improving the character of the light emitted. Not only so, but it is claimed that the actual light-emitting efficiency can be increased, and that the light itself is more pleasant to behold. Probably we shall also be told sooner or later that the colour of the light is more healthy or more suitable for reading purposes or for matching colours. In fact, when once a thing is on the road to commercial success, there is no limit to the advantages that the exploited article possesses. With regard to the Bremer arc lamp, it seems highly probable that Herr Hugo Bremer did really make improvements which have utility. That seems to be admitted by the various interests who are supposed to cast envious glances at his lamp. On the other hand, a spirited dispute might perhaps be raised about the question of novelty. This is always a dangerous sea on which to embark; and the inventor himself probably learns much to his dismay during his voyage on what are probably to him unexplored seas. Then again, quite apart from these, there arises the question of legal ingenuity, pure and simple. Even supposing the invention has both novelty and utility, did the inventor so word his specification and his claims in such a way as to completely baffle the ingenuity of any person who has designs against him? Is there indeed no weak spot in his armour? Herr Bremer seems to have misgivings on this point, and it is therefore of interest to notice the claims made in the original specification, and the amendments which he has wished to make. His original claims were :—

(1) A carbon electrode for arc lamps containing in addition to 15 to 60 per cent. of aluminiferous *metal or metallic base such as* calcium or magnesium, at least 5 per cent. of fluorine, in the shape of a suitable compound, substantially as described, and for the purpose specified.

(2) *A carbon electrode for arc lamps containing in addition to a luminiferous base at least 5 per cent. of iodine or bromine, in the shape of a suitable compound, substantially as described, and for the purpose specified.*

(3) A carbon electrode for arc lamps containing in addition to a luminiferous *metal or base*, at least 5 per cent. of fluorine, *iodine or bromine*, in the shape of a suitable compound, and a compound of boron, potassium or sodium, which have been added to the carbon mixture in a calcined condition, or free from water of crystallisation, substantially as described, and for the purpose specified.

(4) A carbon electrode for arc lamps containing from 10 to 60 per cent. of calcium fluoride, uniformly mixed with the carbon, substantially as described, and for the purpose specified.

(5) *In the mineralised carbon electrodes for arc lamps, the combination of an upper electrode, with a lower electrode having a glassy coating as and for the purpose described.*

The alterations proposed affect the parts in italics. Claims 2 and 5 are to be omitted. The italicised words in Claim 1 are to read "metallic salt, such as a compound of"; in Claim 3, the words "metal or base" are to be replaced by "salt," and the words "iodine or bromine" are to be omitted.

A few alterations are also proposed in the main body of the specification. The following particulars are taken from the specification, and describe the general nature of the invention. The specification is numbered 14,704 of 1899. The inventor says that attempts to mix salts of calcium, magnesium and strontium with carbon have hitherto failed, partly because unequal distribution throughout the mass causes fluctuations in burning, and partly because the slag produced forms eventually a solid ring at the tip of the electrode and extinguishes the arc. Of course, a high percentage of the luminiferous metallic salt was impossible. He asserts that the necessity to calcine the salt for the purpose of removing the water of crystallisation, and so avoid rendering the electrode porous, was unknown. The difficulties arising from the formation of slag are avoided by the addition of a flux, which fuses at the temperature of the arc, absorbs the basic slag, and then falls off in drops or small particles. Flux and metallic salt may be chemically combined, as in the case of calcium fluoride, in the use of which lies one of the main points of the invention. Fluorides are said to be the most useful salts for mixing with the carbon. In particular, preference is given to calcium fluoride and cryolite, *i.e.*, aluminium sodium fluoride. Calcium fluoride produces a stronger and more agreeable light than that obtained with calcium chloride or other calcium salts; the slag too produced by the fluoride is more or less liquid, instead of being hard and solid like the slag produced by other calcium salts. The fluorine should be at least 5 per cent. of the carbon, and the luminiferous metallic matter should be preferably from 25 to 30 per cent. of the carbon. The use of bromides and iodides, which was suggested in the original specification, seems now to be abandoned. Electrodes containing calcium fluoride or magnesium fluoride are apt to give a flickering light unless this tendency is counteracted by adding some boric acid, borax, potassium silicate or carbonate, sodium carbonate or silicate, all of which presumably exercise a binding action.

The next point is to indicate a method of dealing with the slag, which forms a molten viscous liquid. This falls from the upper electrode and accumulates around the tip of the lower carbon, unless steps are taken to prevent this. In the Bremer lamp, it is prevented by the simple expedient of coating the carbons with a glassy covering of borax, or a silicate, or other suitable material, to use the language dear to the heart of the patent agent. The drops therefore slide down the lower carbon without producing any ill effect and without having a tendency to stick to the carbon.

These, then, are the outlines of the invention, and if the tests which have been published on the light-emitting properties of carbons prepared in this way should be substantiated in practice without any subsidiary ill effects, one can well understand that the above specification will be anxiously overhauled by those who are interested in the manufacture of arc lamps. The English rights are in the hands of the British Westinghouse Electric and Manufacturing Co.; and with their energy and enterprise, the Bremer patent may well develop into a second Jandus patent.

◆

The Cooper Hewitt Lamp & Photography.

THE light given by the Cooper Hewitt lamp is not described, even in advertisements, as a thing of beauty. It prefers to stand on more solid ground. The ball-room will probably never make the acquaintance of Mr. Cooper Hewitt's lamp, but we have always been told that it is particularly useful for photographic purposes. We have therefore mentally associated it with the harmless and necessary blue print. But now, according to the *Electrical World and Engineer*, it has invaded the studio of the society photographer, and Mr. Pirie Macdonald, of New York, speaks very decidedly in favour of the new comer. He considers that the arc or incandescent light is apt to be unstable and hard. He uses three Cooper Hewitt tubes, taking 114 volts and 2·8 amperes, and giving about 750 candle power. These lamps are switched on, one by one, as daylight fades. Thus at 2 o'clock, one tube is turned on, and this renders the light as good as it was at 11 o'clock. More are turned on as required; the three tubes together give a working light at night as good as the ordinary daylight was at 11 o'clock. For theatrical work the flash-light is sufficient; but the artistic effects that can be produced by the new rival render it probable that the Cooper Hewitt lamp might be profitably employed for this class of work.

Efficiency of Electric Radiators.

ONE of our contemporaries has committed itself to the statement that the efficiency of all electric heaters is the same. The makers of a type which has just been put on the market claim that it is vastly superior to others, not only as far as its heat-giving capacity is concerned, but also by low consumption of current. With boldness that would be commendable if it were possible to prove such a statement, they assert that to heat 1,000 cubic feet of air with other makes requires 1,000 watts, but their own gives the same result with only 400 watts. It is amusing to find a quantity of work equated to a rate of doing work, for how "watts" can heat a fixed volume of air is a mystery. In what time is the heating done, and how much heat is put into the air? Compare loose statements of this character with the precision of the volume and temperature measurements given by Professor Threlfall in his recent Institution paper. Next, we are informed that radiators with incandescent lamps require 10 to 12 ampéres, which puts them out of court where economy is an object. The unit of electrical energy is equivalent to 3,411 British Thermal units, and this quantity of heat is produced by any resistance in which a unit is absorbed. At the same time and rate of dissipation there is only one factor to differentiate one radiator from another, and that is the temperature of the radiating surface.

The highest efficiency in the case of a heat engine is obtained by raising the initial and lowering the final temperature of the gaseous medium to the extreme limit. In the case of electric heating, the reverse is the case: the best result is obtained by a large radiating surface at a temperature only a few degrees above the final temperature to which it is sought to raise the air to be warmed. But the radiation will then be so small as to be inappreciable, and the whole of the heat will be convected. Human beings delight in radiance, to use Lord Rayleigh's classical term, and unless a heater can warm its environment, mankind, judging by its senses, votes it a poor thing. Nature has been unkind to electrical engineers in some respects, for a similar argument is met with in the popular comparison between incandescent gas mantles and Nernst lamps. The rod of the Nernst burner looks insignificant against the larger area of luminous surface of the mantle, and is decried accordingly. Put an opaque reflecting shade over each and judge of the intrinsic brilliancy of the source by attempting to read in the illumination given, while the agent is hidden from the eye, and a very different aspect is put upon the matter.

◆

Electricians and wiring contractors will find this section of *The Electrical Magazine* an indispensable medium of reference upon all matters relating to the production of electric lighting and heating appliances, as well as the practical application of these devices in every range of commercial activity.

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegrahic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

INTRODUCTORY REMARKS.

Every telegraph and telephone engineer will accord a ready welcome to the advent of *The Electrical Magazine*. Hitherto the literature dealing with these branches of electrical engineering has not been commensurate with the importance of the work, and compares unfavourably with that of the lighting and traction sections of the profession. Some years ago telegraph engineers could boast of a Journal and Society wholly devoted to their interests. At the present day the development of other branches of Electrical Engineering has almost monopolised the columns of the technical press and the proceedings of the Electrical Socities. Similarly in the case of telephony, which at one time possessed a magazine which gave promise of becoming useful, but this came to a premature end, the telephonists, like their telegraph kinsmen, have now to content themselves with a few scrappy paragraphs, an occasional article in the press, and a rare innings at the Electrical Societies. In America, telephony has no fewer than four magazines entirely devoted to the advancement of the telephone art. As to the causes which contribute to this lack of intellectual activity, it might be affirmed that the energies of telegraph and telephone engineers have been confined within a somewhat narrow limit, there being less scope in their operations than in the case of electric light and traction engineers, and although it is not asserted that telegraphy and telephony have yet approached a stage of finality, it will be conceded that electric light, traction, etc., have still a greater field for development. Again, the circumstances under which telegraph and telephone engineers pursue their calling do not make for personal stimulation in initiating or recording new ideas. In the case of of the vast majority of these engineers, their labours chiefly consist in carrying out the ideas of others located in the central offices of the administration. While centralization of authority may contribute towards efficient control, the tendency is in an adverse direction, when the mental work is concentrated amongst a few experts, thus leaving the bulk of the technical staff to act as so many automata. Unity of method may spell economy, but it usually leads to a stifling of enterprise. Fortunately, however, for electrical science generally, electrical engineers, other than those referred to, are more or less thinkers in addition to workers. Engineers employed by companies and municipalities are free to exercise their thinking powers and put their ideas into practice without dread of transgressing hide-bound service instructions; there is therefore no stifling of initiative or caging of intellect. Herein lies the path to progress. It will be one of the chief objects of this magazine to utilise the columns devoted to telegraphy and telephony, in recording the latest ideas, and keeping its readers in touch with the newest developments, and it is hoped that telegraph and telephone engineers throughout the country will take advantage of the opportunity thus offered. They have a great mission to perform in developing these means of communication which have brought continents and towns within touch, and thereby contributing their share to the world's civilisation.

Telegraphs in 1903.

A SURVEY of progress last year in telegraphs is eminently satisfactory, expansion and improvement being steady, if slow. In submarine work the first year's operation of the Pacific Cable has been watched with interest. The practical working of the system has come up to expectations, but the revenue earned has been somewhat disappointing. With a larger volume of business. it is hoped that the financial aspect of the enterprise will be more satisfactory. A year ago it was anticipated that the value of these long cables would be depreciated by the advent of wireless telegraphy. Experts, indeed, had not lent themselves to this view, and, for the present at least, no formidable competition need be feared from wireless systems. Very important achievements have, however, been gained by Marconi, De Forest, Slaby-Arco, Preece, Lodge-Muirhead, Braun, Blondel, and others. Progress in this new and astounding branch of the science, has been rapid enough to satisfy the most enthusiastic. There is no doubt that it will be a valuable adjunct, both to land lines and to submarine cables, although it has its obstacles in etheric disturbances.

Multiple telegraphy, that is, the transmission in one circuit of several messages at one and the same time, is likely to be much assisted by the peculiar adaptability of the telephone as a receiver, to be tuned to different notes. Mercadier and Petit, in France, have achieved satisfactory results in practical working, imposing the waves necessary for the telephone, upon the ordinary telegraph circuits. Van Rysselhaghe, in Belgium, one of the early workers in this field, had shown that the joint use of the Morse and the telephone was practicable. Of late years the idea has been applied in practice on many occasions, and the carrying capacity of many circuits has been thus enlarged.

The use of type-printing telegraphs in the United Kingdom is growing but slowly; while in France there are 897 Hughes' instruments, in Spain 103, in Hungary 120, in Switzerland 69, in Germany 872, in Austria 271, in Italy 205, in the Pays Bas 123, and in Russia 269, there are in the United Kingdom only 92. However, a great advance has been made in the use of Murray's printing system (see page 59) between Edinburgh and London. The tape is perforated for transmission electro-magnetically. Four typists perforating at the rate of 30 words per minute, can feed the machine when working at its highest speed. This is, however, not maintained in ordinary practice. The received tape is passed through a mechanically worked type printer, and the message is then ready for delivery. Thirty messages of ten words each can be disposed of in an hour. The Buckingham printer has also been tried in the British Post Office, between Glasgow and London. The receiving instrument in this case, at once prints off the telegram, instead of perforating a tape, as in the case of Murray's apparatus, so that one stage in the process is saved. The result of the trial of the Buckingham system in Great Britain is not yet known. No doubt systems analogous to these two, if not these identical systems, will in time be in large demand. If the United Kingdom is behind other countries in the use of printers, no other administration employs the Wheatstone Automatic so extensively. Here there are 596 instruments at work, in France 5, Denmark 12, Italy 22, and Russia 28. India is increasing the number of these instruments on main lines, having now 25 working. South Africa is employing a fair number, and New Zealand has six in use.

The Baudot is largely in evidence in France, 231 sets being in use; there is one in London working with Paris, and one in Switzerland, 21 in Italy, and four in the Pays Bas. Of course, the Morse instrument employs by far the larger number of signallers throughout the world, duplex and quadruplex Morse having increased in the year 1903.

Methods of construction of overhead lines and submarine cables have not shown any material changes lately. The use of copper instead of iron wire is increasing, and, except in the United States, aluminium does not appear to be in demand as a conductor.

Large telegraph offices are becoming alive to the advantages of the switch-board for connecting over the occasionally worked circuits in the manner of telephone connections. A central board, with drop indicators, operated with plugs and jacks, with pilot and supermisory lamps, appears both to save instruments and operators. For not only can lines which formerly sent their telegrams through the central, be put at once in direct connection with each other, and the repetition in the central be obviated, but the staff in the central can be used to the greatest advantage, with a reduced number of instruments, by the continuous occupation, and avoidance of the idle periods, which a switching system affords means of securing. Brussels, Amsterdam, and London are illustrations of this very advantageous innovation.

In submarine telegraphy the important devices of Brown, Muirhead, and Gulstad, for reinforcing the signals at intermediate stations, are potent in improving the carrying capacity of long cables, and will lead to increased economy and efficiency.

The extension of underground wires in England has proceeded in the year under review, and communication between London, Liverpool, and Manchester through paper insulated cables will shortly be established.

Wireless Telegraphy in 1903.

The progress made in wireless telegraphy during the past year has not been marked by any very sensational discoveries or results, such as the previous year afforded, but has consisted for the most part in a number of improvements in the direction of reliability and efficiency in working, marking a steady advance which is perhaps preferable to the achievement of startling results in directions which cannot be rightly regarded as within the legitimate sphere of this comparatively new science. With the aerial, various devices for reducing its height and still increasing its radiating power have been tried, by which the capacity is increased, evenly distributed, and large compared to the inductance, thus tending better to the production of pure sine waves. Of this Prof. Fessenden's cage aerial and Dr. de Forest's multiple aerial are examples. With the same object the former also designed the compound aerial in which the wire itself is surrounded by finely divided magnetic material embedded in a dielectric. Prof. Stone, in a similar manner, in his sheathed aerial, provides the substance of high specific inductive capacity in the insulating material which separates the outer magnetic layers from the aerial wire itself, but he adds additional capacity to neutralise the inductance introduced by the sheathing, by placing a capacity area at the upper end of the structure. Unfortunately data are not yet available as to the results obtained with these theoretically very promising arrangements.

II. The outlook is distinctly promising as regards transmitters and transmitter circuits. The limitations of the induction coil have given rise to the use of alternators for supplying the energy required, but this is no new feature. It was the spark-gap itself which prevented the emission of continuous trains of oscillations, owing to the conductivity of the gap after the first discharge. Placing the gap under pressure, as suggested by Mr. Jervis Smith, raises the discharge potential for the same size of gap, and, at the higher pressure employed by Prof. Fessenden, the radiation is three times as great as for the same discharge potential in air (which latter would, in fact, not be obtained owing to the great length of gap making the discharge aperiodic). The advantages of the extreme suddenness of the breakdown of the gap under high pressures are, however, to some extent set off by the conductive power of the medium being restored more slowly, thus increasing the inactive period. More recently the Duddell singing arc and the mercury vapour lamp have suggested new means of obtaining this more continuous radiation, and the interesting experiments of Messrs. Simon and Reich, though not yet concluded to their satisfaction, have shown that it is possible to get, with the latter device and a high potential continuous current, trains of oscillations of frequencies up to 10^5 and 10^6 per second. The vacuum-gap, besides permitting the use of an increased discharge potential with the same length of gap, in contradistinction to the air-gap, allows the intervals between the discharge series to be made exceedingly short. It is in the possibility of thus generating undamped wave-trains that, according to these physicists, the chief direction to look for advance lies.

A further problem awaiting solution is that of selectivity, or the prevention of interference in messages. Prof. Stone in America, Prof. F. Braun, and Mr. S. G. Brown all employ different means for attaining the desired object, but the only practical results available to date are those obtained with the directed system of wave emission of Prof. Artom, in which two orthogonal electric waves of equal amplitude and periodicity, but differing in phase by a quarter period, are sent out in a given direction. Preliminary experiments made with the help of the Italian Naval officials appear to have been satisfactory, and official announcement of the results of the more prolonged later trials are expected very shortly. Combinations of electrical and mechanical selective methods are also being tried by Prof. Fessenden and others.

III. More definite results have already been obtained with receivers and receiver circuits, quite a number of the former, based on different novel principles, and of greater or less sensibility, having been brought out. Of the coherer type there is the Lodge-Muirhead mercury coherer, the steel tripod self-restoring coherer of Mons. Branly, and the Maskeleyne coherer, of which details have not yet been published, though it may be described as a simple self-restoring coherer, without liquids or moving parts. Of current operated receivers the magnetic ones of Prof. Fessenden, Herr Huth, Prof. Fleming, and Mons. Tissot may be mentioned. Based on other principles, the polarisation cell detector of Herr Schloemilch, the platinum loop bolometer and the barretteer of Prof. Fessenden, and the new electrolytic responder of Dr. de Forest all testify to the ingenuity with which many promising properties have been practically applied to the detection of Hertzian waves. Of the above instruments Prof. Fleming's detector has the additional advantage of readily giving quantitative results, the want of a metrical detector having been a serious drawback to rapidly obtaining experimental results. The Schloemilch and de Forest detectors, based upon the property of Pupin's asymmetrical cell, are said also to give quantitative readings with a galvanometer inserted in the cell circuit in place of the telephone; all current operated receivers, in fact, give metrical results, but not always in an easily utilisable form.

With receiver circuits attention has been directed mainly to two considerations: (1) The attainment of a pure sine-wave form of oscillation, to enable the fullest advantage to be taken of the resonant rise of potential, and (2) Selectivity, whether by syntonic or other means. As regards (1), Prof. Fessenden with the barretteer responder has succeeded in getting a resonant rise of 400 per cent., while Count Arco has stated that the usual rise he obtains is 2½ per cent., 10 per cent. being practically a maximum with coherers. Prof. Stone has been working, besides, at the problem of (2), and weeds out waves other than those of the desired quality by a series of selective circuits after the manner of Ehret. He also has devised an arrangement by which the direction of the received waves can be determined by two similar aerials, so disposed that by rotating the pair, the position in which the differential effect of the two aerials produces no sound in the receiver, indicates the direction of the arriving waves. A similar arrangement has been described by Prof. Braun as due to the late Capt. v. Sigsfeld. Prof. Fessenden also employs a number of linked circuits at the receiver, but chiefly for the purpose of strengthening the signals. In other directions Dr. de Forest is now using an unsymmetrical loop (after the Slaby principle) by so connecting the five vertical wires which are in parallel for transmitting, that in receiving, only four wires are in parallel, the fifth being joined at the upper end in series with the other group. A new receiver arrangement, due to Mr. Maskeleyne, is also of the Slaby type, but details may not yet be given, though the arrangement was recently tested at the trials of the de Forest system, before the representatives of H.M. Post Office with satisfactory results.

The year has also produced some other instruments of general utility and very great importance. The portable tuning devices of Count Arco enable the constants of an oscillatory circuit to be determined by a few simple trials, though the results obtained with one form are only on an arbitrary scale of values. The wave-length-meter of Herr J. Döwtz gives directly the actual values of the wave-lengths in metres, to a high degree of accuracy, by merely turning a pointer until a maximum reading is obtained on a Reiss' air thermometer, when the wave length is read off on the dial under the pointer. Thus the tuning of a circuit, formerly a long and tedious operation, is now obtained as easily as, for instance, a Siemens' dynamometer reading.

Dealing now with wireless telegraphy in general, and telegraphic results, the chief event has been the confirmation of the famous S signals obtained in 1902 from across the Atlantic. On two days also, commercial wireless Atlantic telegraphy was an accomplished fact, as evidenced by the appearance of a Marconigram column in the *Times*, though it as mysteriously ceased appearing, and has not since been resumed. On the other hand, the publication of a Marconigraph newspaper on board some of the Atlantic liners has become a regular feature, and the service itself has already been put to a number of unlooked for uses. At the yacht races for the America Cup, the competing systems did not come off very well, though the de Forest system appears to have scored somewhat, but this is a debateable question. In the army manœuvres the Lodge-Muirhead installations rendered good service, but in the naval manœuvres no sensational results were obtained, as in 1902. The Italian navy is the one most actively engaged in wireless experiments, and Prof. Artom's polarised wave system seems to promise far reaching results in the not distant future. In the German army the Braun system has been adopted, and large numbers of the now well-known type of portable stations are in use. The U.S. Navy has also installations on the Slaby-Arco system.

Wireless telegraphy has been introduced in China at the Italian Legation at Pekin, to communicate with the ships at Taku. In the same way installations are arising in the Philippines. Japan is developing a system of her own. Russia has a large number of installations on the warships in the East, but the site of the land stations is not published. Across the Behring Straits there are stations being built and operated on the North Pacific Coast, and, nearer home, the large central Marconi radiographic installation is being erected near the coast, not far from Rome, to eventually communicate with Argentine, where stations will shortly be erected. Finally, the status of wireless telegraphy is getting to be more closely defined, owing to the action of the International Congress. From the Conference itself little has as yet resulted beyond the general agreement to give precedence to signals of vessels in distress where humanly possible. This is, however, a very important point. The action of the French Government, and the legislation of several of the British Colonies have somewhat restrictive effects, but it is quite reasonable to expect measures to be taken to prevent a treasonable use of this otherwise beneficial means of communication; probably also the respective governors would be willing to permit stations for legitimate experimental work to be erected. It is to be hoped, in any case, that when legislation comes nearer home, due regard will be given to this. For the immediate future there is ground to hope that the next twelve months will bring forth most important results, not so much perhaps in long distance work, which has already been proved possible, but in the more urgently needed qualities of directive power imparted to the radiations and selective power to the receiver arrangements.

The Murray Printing Telegraph. . . . .

By J. S. SMITH, A.I.E.E.

◆

MANY attempts have been made since the early days of Cooke and Wheatstone, of Bain and Morse, and of other pioneers of telegraphy, to perfect a system of printing by telegraph, but until quite recently, unqualified success has not attended the efforts of any one individual.

It is true that the late Professor Hughes perfected a very ingenious instrument, which has held sway in most continental countries for over thirty years, but it has the disadvantage of printing in tape, and not in page form, and its speed is limited to that of hand signalling.

It may be interesting to recall the fact, after the lapse of nearly three score years and ten, that the first electro-magnetic telegraph of Bain, over which such fierce controversies arose between his partisans and those of Wheatstone, was one by which the telegram was printed in page form.

The receiving apparatus consisted essentially of two electro-magnets, one actuating a cylinder upon which the paper was fitted, and the other operating a shaft and wheel, upon whose periphery the alphabet was impressed. A third shaft carried an inking roller, capable of moving up or down, and always presenting a freshly inked surface to the type wheel. Similarly the cylinder secured a gradual elevation and depression by means of a spiral screw, upon which it travelled, and thereby always presented a fresh surface of paper to the printing wheel, situated between the cylinder and the roller.

In signalling, a dial plate having all the alphabet inscribed around its circumference, and a revolving hand, were employed. Underneath each letter a small aperture was provided for inserting an ivory peg at the particular letter desired. The hand was kept rotating by means of clockwork, and current impulses were sent to the line as it passed over each letter, these impulses energising two electro-magnets at the receiving station—one giving a rotary motion to the type wheel, corresponding to the motion of the hand itself, and the other operating to imprint on the paper the letter arrested. This simple machine accomplished its work with remarkable accuracy over short distances, but not with very great speed.

It is also singular that Bain was the first to adopt perforated paper tape, which plays such an important part in the Murray system, for the automatic transmission of telegraphic signals. This he did to meet the requirements of the very high receiving capacity of his electro-chemical instrument. But although Mr. Murray has been forestalled in the adaptation of perforated ribbon to transmission, and in the accomplishment of type-printing by telegraph, there is absolutely nothing akin in the theory and principle of his invention to those mentioned.

Briefly summarised, Mr. Murray provides for the automatic signalling of his messages by means of:—

(1) An electrically controlled perforator for punching letters and symbols in a paper ribbon.

(2) An electrically driven transmitter for signalling to the distant station, letters and symbols corresponding to those on the perforated paper.

(3) An electrically driven and synchronously controlled recorder, for receiving the transmitted signals in the form of perforated ribbon.

(4) An electrically or hand driven typewriter, which by mechanical means prints the letters and symbols corresponding to the perforations received on the paper ribbon.

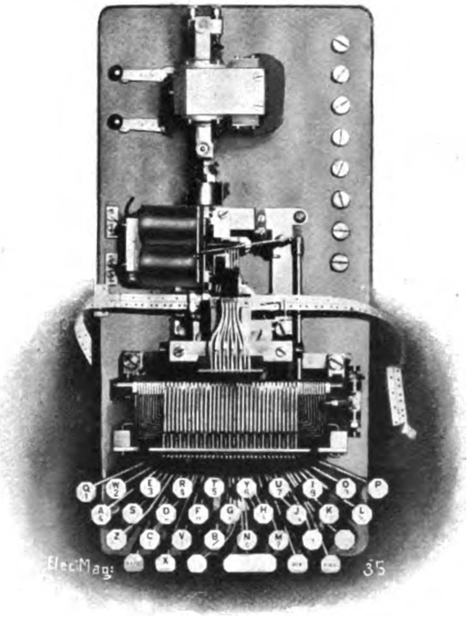


FIG. 1. THE PERFORATOR.

THE PERFORATOR.

Fig. 1 shows the perforator, with its typewriter keyboard, beneath which light steel bars, called, from their peculiar shape, "fiddlebows," control certain combinations of the punches employed for perforating the paper with the required characters. Each letter and symbol partakes of a particular number, and a special arrangement of perforations, as distinct as those forming the Morse alphabet.

The paper ribbon is fed into a slot between a die plate and the punches, by means of a shunt-wound motor and an electro-magnet whose armature controls a sprocket wheel for guiding the paper over the die plate, and a ratchet wheel and escapement, which propels the paper forward. Normally the armature of the paper-feeding or spacing electro-magnet is attracted towards the core of the magnet, but on a key being depressed, the armature is released, and by the force of a retractile spring, the escapement, acting on the ratchet wheel, which is fixed on the same shaft, first allows the paper to be carried forward a third, and afterwards two-thirds of the distance required for the perforation of a letter, namely, half-an-inch.

The lever that thus releases the armature of the spacing electro-magnet, on completing its excursion between two contact points, then energises the punching electro-magnet, whose armature is attracted, and operates a certain number of punches, of which there are ten, in combinations representing the particular letter whose key is depressed.

As the keys require but a nimble touch in order to execute the work explained, and as a speed of fifty words per minute is not unusual by experienced typists, it will be recognised that a much higher speed can be obtained by this means than by hand signalling, in dots and dashes, with spaces between.

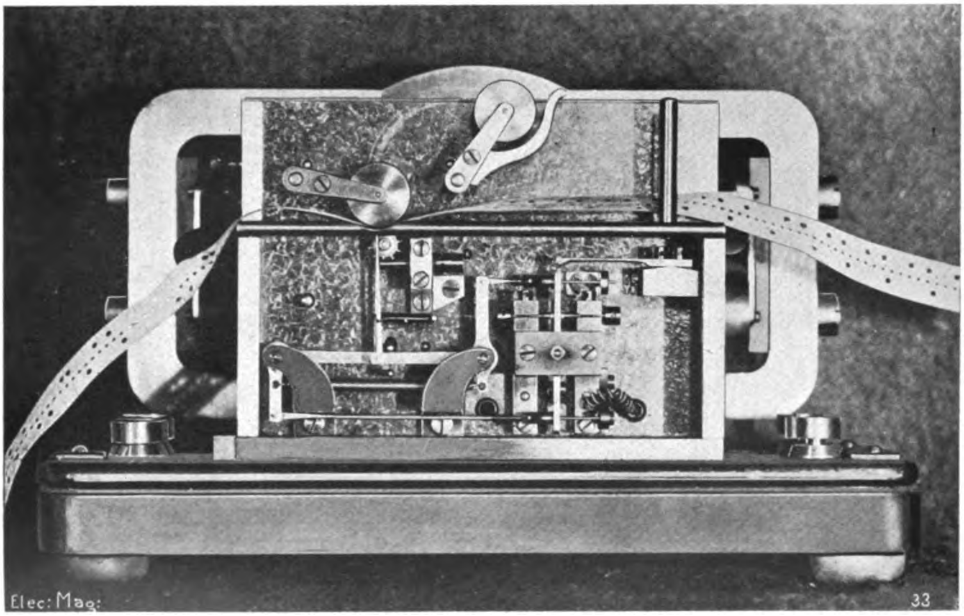


Fig. 2. The Transmitter.

THE TRANSMITTER.

Fig. 2 represents a front view of the transmitter, which is driven at a uniform velocity, by means of a motor behind, as shown in Fig. 3. The mechanism is very simple, consisting merely of clockwork operated by the motor, or phonic wheel, and geared with the spindle of a crank, operating a rocking lever, capable of oscillating between two contact points, connected with the positive and negative poles of some source of electro-motive force, the rocking lever itself being joined to the line.

When set in motion the line-connected lever transmits alternately positive and negative electric impulses to the distant station in rapid succession, but when the prepared paper ribbon is inserted, as shown in the figure, the positive and negative currents are allowed to flow to the line in strict conformity with the character of the perforations.

The distance of the play of the oscillating lever is limited by means of two reciprocating rods in conjunction with two prickers that engage themselves in the perforations so that the lever can only connect the line with one or other of the contact points, according as one or other of the prickers gets freely through a perforation in the paper ribbon.

THE TRANSMITTING VIBRATOR.

The motor fitted behind the transmitter and shown in Fig. 3 receives its energy in the form of electrical pulsations from the transmitting vibrator, depicted in Fig. 4.

On either side of an iron reed is fitted an electro-magnet, the circuit of each being alternately connected and broken by the break and make contact springs on either side of the reed. One of the electro-magnets is connected with one side of the transmitter motor and the other with the opposite side of this motor, so that alternate pulsations are given to each, thereby maintaining the phonic wheel, which is pivotted centrally between them, in steady and constant rotation, and as the axle of this wheel transmits its power to the clock-work inside, a perfectly uniform speed is secured for the transmitter.

THE RECEIVING VIBRATOR.

The signals transmitted in the manner described are received at the distant station by a sensitive relay, whose tongue and marking contact stop are connected in series with three local relays, each performing an important part in the succeeding operations; but first, a receiving reed (Fig. 5) is set to vibrate at a speed a little in advance of the transmitting one. This reed, as will be seen from the diagram, has only one electro-magnet, which in conjunction with the break and make contact point on the opposite side, acts as its motor. The other two flexible contact springs, one on either side of the iron reed, are connected respectively with the spacing and punching electro-magnets of the recorder, shown on the right of Fig. 6.

It will be understood that the vibratory speed of a reed, on the buzzer principle, is regulated by (1) its propinquity to its motor or electro-magnet, (2) the electrical pressure applied to the reed circuit, and (3) the mass and distribution of the mass of the reed itself; the latter condition being varied by means of the weight carried on its free end, in the same manner as the bob of a pendulum. The receiving reed, as will be observed from Fig. 5, has yet another means of adjustment, an original and clever device of Mr. Murray's, consisting of two resilient, or buffer springs, one on either side of the free end of the reed. The effect of thus limiting the amplitude of vibration is not only to simply accelerate the speed, but to impart a return motion to the reed by the cushioning effect of its impact against the springs.

THE RECORDER.

The function of the recorder is to receive on the tape provided for the purpose, perforations exactly corresponding to those originally punched by the perforators and passed through the transmitter. This is accomplished by means of a shunt wound motor, whose armature is connected with a shaft at the opposite extremity of which is fitted a ratchet wheel, controlled by an anchor escapement and actuated by the armature of the spacing and paper-feeding electro-magnet.

The paper, which has been previously centre-holed, is conducted through a slit over a die plate and underneath a punch, by means of a sprocket, or star wheel, whose teeth engage with the centre holes of the paper. A drum and coiled spring breaks the mechanical connection of the shaft midway between the motor and the ratchet wheel, thereby enabling the motor to run continuously, without carrying forward the other parts fitted on the spindle, unless when the anchor escapement releases the ratchet wheel, on the spacing armature being actuated by the current in that circuit.

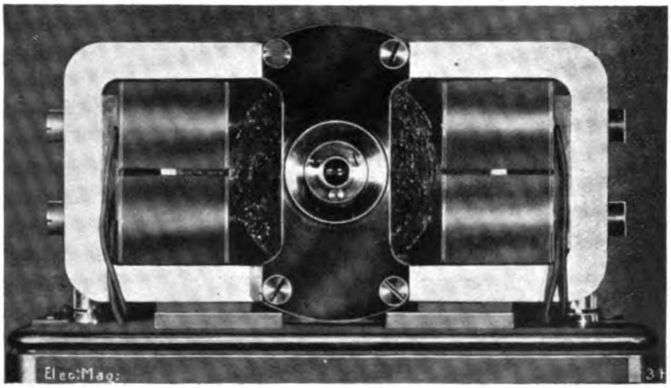


Fig. 3. Transmitter Motor.

The contact spring on one side of the receiving vibrator connects a local battery with the spacing electro-magnet, and gives to it, with each vibration, a momentary impulse. This would enable the escapement to act continuously and thereby keep the paper in perpetual motion, but the small electro-magnet, seen in front of Fig. 6, by an ingenious application of a worm and a little contact spring disconnects this circuit except when the line pulsations attract its armature. The spring then closes this circuit and allows each pulsation to act on the armature of the spacing magnet, and concurrently on the ratchet wheel and escapement, thereby maintaining a perfectly uniform speed of the paper ribbon, fast or slow, according to the rate of vibration of the reed itself.

On the opposite side of the reed another contact spring introduces, in like manner, a local battery in the circuit of the punching electro-magnet, but there is also included in

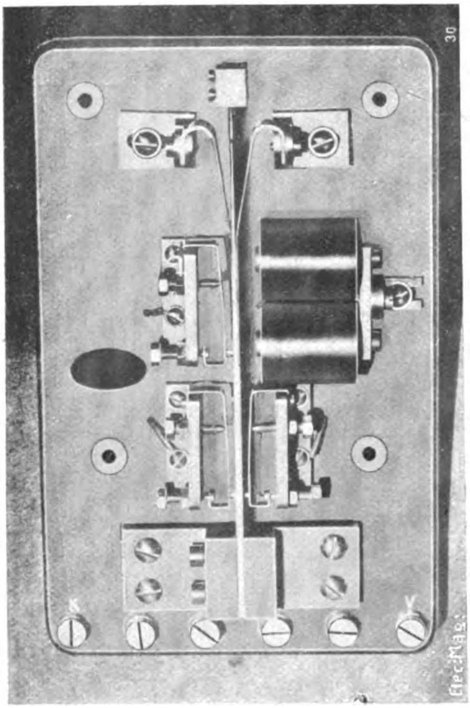


FIG. 5. RECEIVING VIBRATOR.

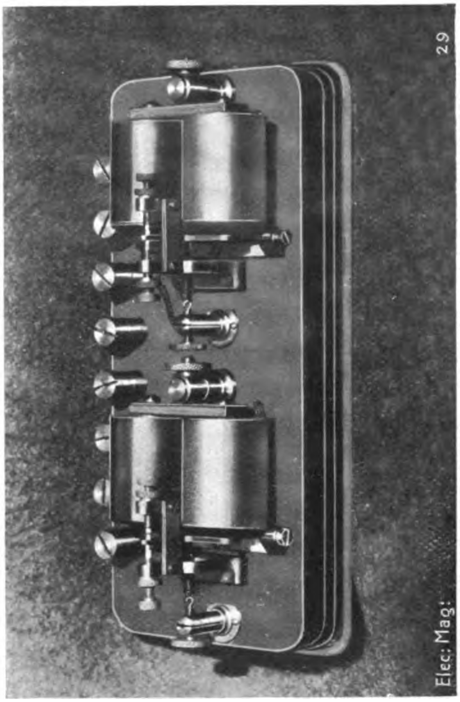


FIG. 7. LOCAL RELAYS.

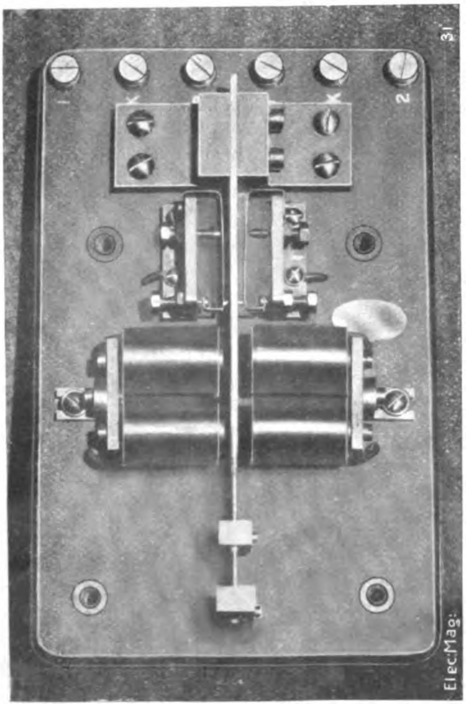


FIG. 4. TRANSMITTING VIBRATOR.

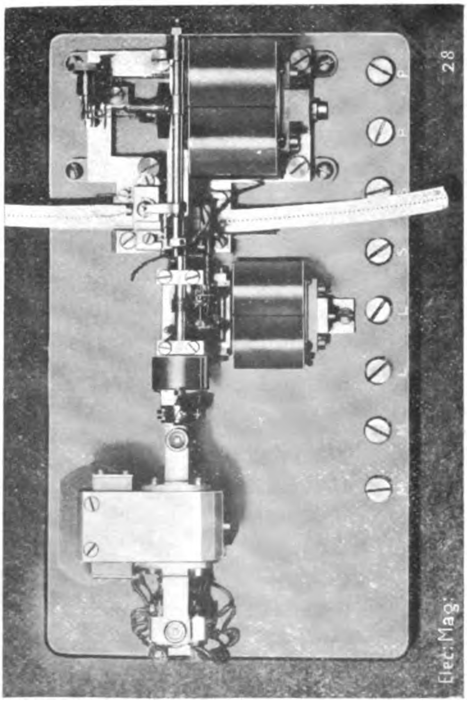


FIG. 6. THE RECORDER

this circuit the armature and contact stop of the local punching relay, shown on the left of Fig. 7.

LOCAL RELAYS.

The function of the punching relay is to allow the punching circuit to be operated only when marking or punching currents are received in the line circuit. The vibrating reed therefore only completes this circuit when the punching contact on the vibrator and the armature of the punching relay are acting in synchronism. This synchronism is maintained by the aid of the second of these local relays, described by Mr. Murray as the governing relay, and shown on the right of Fig. 7. It is connected in series with the punching and the paper-stopping relays, all of which are energised by a local battery, and introduced between the tongue and the marking contact stop of the main line relay, so that they only act when the line relay itself is influenced by the received current impulses.

The governing relay performs the same duty as, but in a simpler way than, the correcting relays in Delaney's synchronous multiplex system. The two contact stops, between which the armature lever operates, are connected together, and form a common junction with the vibrator motor circuit. The tongue is also in the circuit of the vibrator, which is thereby broken, with every excursion of the tongue between the two metallic stops, or, in other words, with every line impulse. As the receiving reed is regulated to vibrate about two or three per cent. faster than the transmitting one, this momentary break in its circuit tends to retard its speed, and to maintain it in the same vibratory condition as the transmitting one, thereby bringing both into perfect unison.

THE PRINTER.

The final performance in this cycle of operations is the printing of the telegram for delivery to the public, or for further transmission beyond the station at which it has been received. This is accomplished mechanically on an ordinary typewriter of the Barlock pattern, as depicted in Fig. 8.

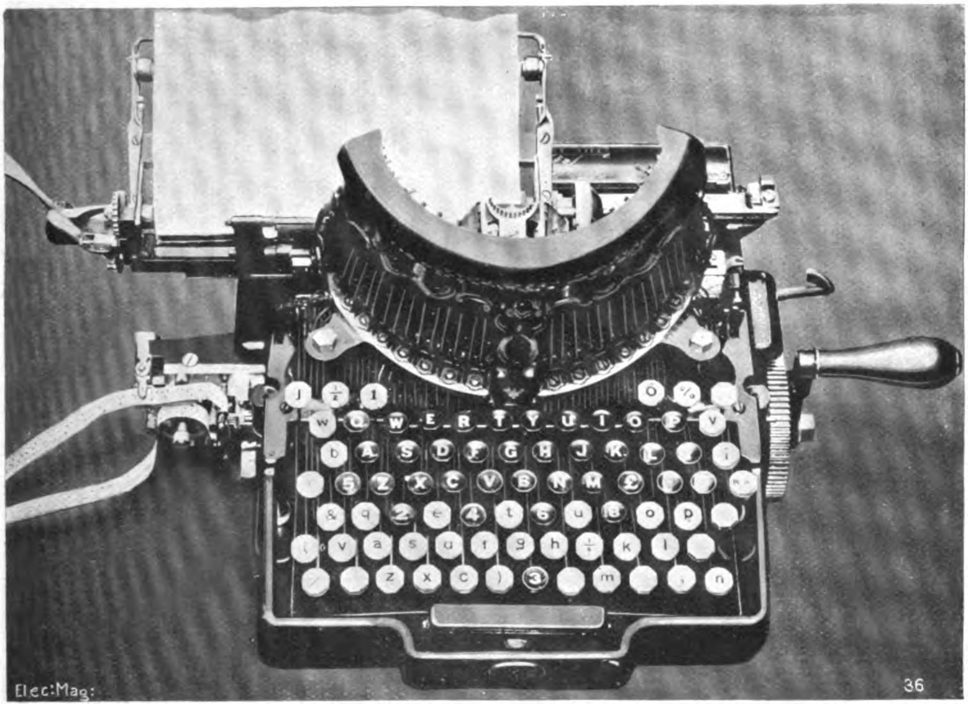


Fig. 8. The Printer.

The keyboard is retained for filling in any letters that may have been accidentally dropped, or for making necessary corrections.

Fig. 9 gives a view of the mechanism applied to the machine by Mr. Murray.

The received paper tape is passed over a wheel, the teeth of which engage in the centre

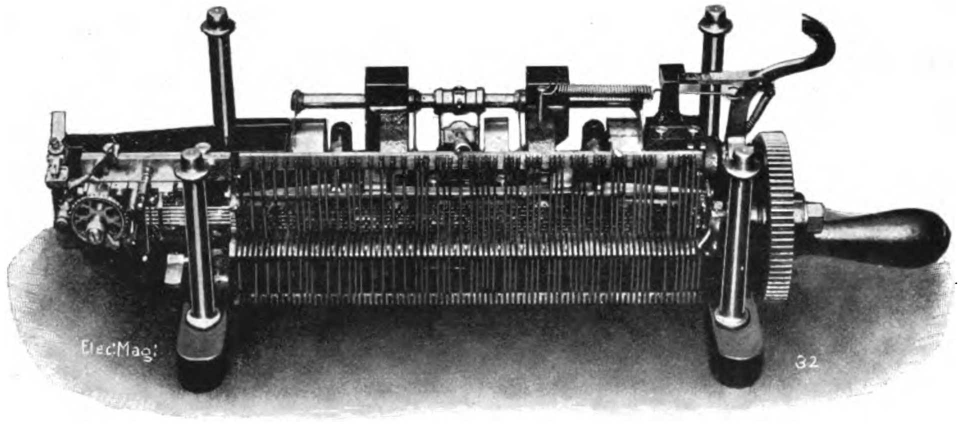


Fig. 9. Printer Mechanism.

holes, and conduct the paper over the face of a die plate having five holes, corresponding in size and in distance from one another to the five possible positions for any combination of perforations composing any single letter. Facing these holes in the die plate are the points of five longitudinal rods, capable of penetrating through the holes in the die-plate, by the action of a motor-driven cam. These rods have teeth cut out of their front edge, like those of a comb, and are designed to engage, in certain combinations, with the key-connected levers, so as to operate any particular letter key. As the paper passes over the die plate, it presents to the points of these five reciprocating rods, a certain number of perforated and unperforated spaces, according to the specific letter. The perforated spaces admit the passage of certain rods through the die plate, while the unperforated spaces block the passage of others. The rods therefore take up a certain position for each and every symbol, and the particular alignment of their teeth at any time, determines the action on the printing levers and the letters connected therewith.

This mechanical device acts with inspiring accuracy, and a speed of 150 words per minute has been obtained by its means.

Rapid Type-Printing Telegraph.

In addition to the type-printing telegraph used in connection with the teletyping service described in the following note, the Siemens & Halske Company have just brought out another kind of type-printing telegraph, for rapid service. The apparatus is analogous to the so called automatical telegraph, where an apparatus similar to a typewriter pierces for each letter to be telegraphed certain holes in a continuous paper ribbon. The latter, on being drawn along through the rotating telegraphic sender, will throw automatically corresponding currents into the line. As the Siemens apparatus is capable of telegraphing 2,000 letters per minute, the telegrams transmitted by a large number of officials will be sent on the same wire. Two holes are pierced for each letter, the letter itself being printed immediately above in plain ordinary printing characters. The perforating may even be effected by the public itself. A disc, where the various letters are cut out as in a pattern, rotates at a speed of 2,000 revolutions per minute between a spark gap and a continuous ribbon of photographic paper. Whenever a spark passes in the gap, a silhouette of the letter happening to be in front of the gap will be projected on the paper ribbon, which on running through sponges impregnated with developing and fixing liquids will complete the photographic process.

The Berlin Type-Printing Telegraph Station.

The type-printing telegraph service, just installed in Berlin, is intended to afford a useful complement to existing telegraph and telephone systems. In telephonic communication there is a possibility of mistaking the spoken words, and the absence of an acknowledgment in writing of the transmissions, such as is frequently required for business purposes; on the other hand, conversations may be overheard by a third. A similar interception of a despatch is possible also in the case of the Morse telegraph.

The "Teletyper" (Ferndrucker), as constructed by the Siemens & Halske Company, belongs to the class of type-printing telegraphs, from which it is, however, distinguished by the extreme simplicity of its working. The operation of the apparatus may, in fact, be acquired by anybody in the shortest possible time, the teletyper being nothing else than a teletypewriter.

The central station just opened in Berlin is intended to ensure mutual communication between any two subscribers to the new system, as well as the simultaneous transmission of special despatches, such as Exchange telegrams, from one sending station to any desired number of subscribers. The apparatus is likely to be useful also in the case of the person rung up being absent, as the telegram, being printed on his receiving apparatus, will be found on his return.

The type-wheel is provided on its periphery with two circles of types, corresponding with the letters and figures and signs of punctuation respectively, the type-wheel being adjusted for either of the circles by means of a shift key. The printing takes place simultaneously in both the sending and receiving apparatus, no matter whether there is or is not, somebody operating the latter.

The working of the newly opened central station is quite similar to that of a telephonic station. There is a switch board, including indicators and catches, for 100 subscribers. As soon as a subscriber strikes the calling key of his apparatus, the official in charge of the switchboard at the central station is advised by the indicator of the subscriber in question dropping, and a bell being rung, when the official will put himself in communication with the caller, ask him for the desired connection, and connect the two subscribers, so that their respective apparatus are immediately ready for mutual communication.

❧

TELEPHONE NOTES.

The Telephone in Paris.

THE report on the Postal Telegraph and Telephone section of the general French Budget for the year 1903, by M. Sembat, forms interesting reading to those in this country who advocate the nationalization of telephones, a question, which in the not distant future, will come within the sphere of practical politics. The report referred to deals with what has been termed "a telephone crisis in Paris." It appears that the subscription in Paris is £16 per annum for unlimited service, and that a promise on the part of administration to reduce this rate to £12 has not yet been carried out; consequently, in Paris the number of telephones compares unfavourably with the majority of other European cities, while the use of the instruments is comparatively small. On October 31st, 1902, there were altogether 40,555 stations in Paris, an average of 1·5 stations for every 100 inhabitants, a striking contrast to Stockholm, where there is one telephone to every eight inhabitants. In Paris, fully one-half of the telephone subscribers do not exceed five conversations per day, while less than 9 per cent. use it more than 15 times. These facts and figures fully justify M. Sembat in calling prominent attention to the unfavourable condition of Paris telephones, and as a partial remedy advocating the adoption of the message rate system. This system has been extensively adopted in America, Europe, Australia and Japan, and in advocating its adoption he points out that in New York City, where the usual yearly increase of telephones was a little over 500, the number rose to close upon 7,000 whenever the message or toll system was introduced. In pointing out the inferiority of the telephone system in Paris, M. Sembat is particularly scathing in his remarks. Not infrequently, telephone users, after attempting to be placed in communication with their correspondents, give up the attempt in despair, and rush off in a cab to the office or residence of the correspondent desired. While the reduction in the flat rates, and the introduction of a measured service may tend towards an improvement in Paris, it is evident that no thoroughly satisfactory system can be expected until the administration of the telephone ceases to be a subject of political controversy.

The Training of Telephone Engineers.

AMIDST the great developments of technical education in this country, it is a matter for regret that the important question of imparting a thorough practical scientific tuition to young telephone engineers has not received the attention it deserves. The Americans, with their usual progressive characteristics, have for more than two years possessed a special school for telephone engineering at Purdue University. The curriculum extends over a period of four years. The student during the first two years attends the ordinary classes of the general electrical engineers; in the third year the lectures on several specific mechanical subjects are omitted, and special lectures are substituted on the rudiments of telephone engineering. The lectures begin with a description of the old earth series system, the metallic self-restoring drop system, and lead up to descriptions of the multiple common battery system. During ten hours a week the student supplements his studies by practical work in the laboritory, in construction and various kinds of tests. In the last year particular attention is given to the study of different telephone systems, together with the design and laying out of complete exchanges and telephone net-works. The laboratories are amply equipped with all kinds of telephonic and electrical testing apparatus. There are at present ten fourth year students attending the University, while the students in the lower classes are 43 in number. Telephone engineers in this country who look back upon the rule of thumb methods of acquiring a knowledge of telephone work cannot but be envious of the opportunities afforded to the youth of the United States, and it is to be hoped that some day facilities for a similar training on equally satisfactory principles will be afforded the prospective Telephone Engineers of the United Kingdom.

❧

WIRELESS TELEGRAPHY NOTES.

Two New Stations.

THE Berlin Gesellschaft für Drahtlose Telegraphie has installed on the Norwegian Loffoden Islands, two wireless telegraph stations 50 km. distant, the points chosen being separated by high and continuous rocky masses ,so as to oppose material obstacles to the passage of the electric waves. These experiments were made with a view of testing the safety of the system under especially unfavorable conditions. The above statious were operated by means of dry-cells, so as to ascertain whether very small amounts of energy would allow of communication being secured over the distance of 50 km. On account however, of the obstacles interposed in the direction of telegraphing, the primary energy of a limited number of dry cells was found to be insufficient, an amount of energy as high as about 200 watts being necessary to ensure a safe communication.

On the other hand, the above Company had some weeks ago made attempts to obtain wireless communication from their Oberschönweide (near Berlin) gigantic station as far as Munich and Vienna. On acconnt, however, of the heavy storms prevailing these experiments had to be discontinued, the storm in Berlin tearing off the balloon carrying the antenna from the rope; in Munich it was equally impossible to let up balloons or kites because of the violent storm. The experiments which were contemplated for some time between the above Oberschönweide station and Karlskrona, Sweden, have been begun on Dec. 16th.

Experiments with Moving Trains.

According to the *Elektrotechnische Zeitschrift* Herr Biscan, Director of the Teplitz Technical Institute, has carried out experiments in wireless telegraphy between moving trains on the Teplitz-Aussig line and the stations with very successful results. The Railway board provided him with a saloon carriage fitted with an accumulator battery giving 100 volts and a complete installation by the A. E. G. The Morse apparatus, carrying also the coherer, was supported on springs, and the carriage was attached to the ordinary trains. The sending and receiving aerials consisted of copper wires 2 mm. in diameter placed on insulators on the outside, at the side of, and covering the whole length, of four carriages. At the stations, wires were supported by insulators from the telegraph poles for 40 metres in both directions. At a distance of 7 kilometres messages were exchanged and clear signals obtained.

Wireless Fire Alarm.

In a recent number of *The Electrical World* appears an illustrated description of the Guarini wireless fire-alarm system, an outline of which has already appeared in *The Electrical Review*. A practical installation is said to be in course of erection in Brussels. The inventor uses an alarm thermometer closing an electric circuit, releasing a clockwork driven disc provided on its periphery with a number of projections corresponding to letters or numerals for indicating the identity or location of the spot where the alarm is fixed. The reception of an alarm signal lights a lamp and rings a bell at the receiver station and also gives a signal throughout the building where the fire is. Mr. Guarini attributes the origination of the idea to Signor Mollo of the Naples Fire Department, but he has himself worked out the details.

Measuring Wave Lengths.

Prof. Slaby, in the *Elektrotechnische Zeitschrift*, describes a new instrument of his invention for measuring the wave-length in oscillatory circuits. He uses the well known Tesla principle, first applied by him to wireless telegraphy, of the additional wire of length $\frac{1}{4}\lambda$ added on to one end of the aerial of length $\frac{1}{4}\lambda$. This wire when wound into a coil was called by him a multiplicator. The wire is wound on a stick of wood or ebonite and turns are short circuited until resonance is obtained, which is recognised by the small Tesla discharge at the free end, which discharge is made plainer to the eye by causing it to act on a screen of bromine platinocyanide among which latter pulverised gold-leaf is mixed.

Practical Tips on Transmitters.

Dr. de Forest has recently contributed a very interesting article to *The Electrician* on Wireless Telegraph Transmitters. He gives a number of practical tips, which have never before been made public, especially in the matter of insulating the aerial. He advocates sealed oil condensers of ample size to safely give the required capacity, in place of Leyden jars. He points out how fallacious the usual method is of calculating the energy in the aerial circuit by a hot wire ammeter, and considers this erroneous view is responsible for the idea that the coherer is an instrument of practically infinite sensitiveness. He shows that, supposing the energy put into the wire is put into the aerial for a one hundred thousandth of a second at a rate of 1 kilowatt, the radiation takes place from the aerial at a rate enormously greater. Thus the effect on the ether is more of an impact than the rate of charging the aerial would lead one to expect, and is an additional argument in favour of some means of more continuously charging the aerial without long inactive intervals. He advocates the use of the Duddell arc for producing undamped wave trains as Messrs. Simon & Reid suggested, though they have found the mercury vapour lamp to be greatly superior for this purpose.

Anent Patent Applications.

In a recent Editorial the *Electrician* observed that the number of applications for patents in wireless telegraphy was declining, and that patents now issuing were mostly those of foreigners or cranks. Since that time, it is true, not many patents on the subject have been issued, but those recently published include five taken out by the Marconi Co. and others, and of which Prof. Fleming is responsible for two or three. Are these foreigners? On the other hand *The Electrical World* reports that in the U.S. quite a flood of patents on the subject is issuing. One of these, granted to Prof. Fessenden, deals with the use of one or more reactance circuits between the aerials and the sending and receiving circuits with the object of securing selectivity and sharp tuning. This resembles the method of Stone and the much earlier though not so well known one of Ehret.

Polarized Wave Experiments.

So few results are available as to wireless telegraph wire directed wave-systems that the notes in *L'Elettricita* on the earlier experiments with the polarized wave system of Prof. Allessandro Artom is of special interest. These experiments were carried out with the help of Commander Bonoma, of the Italian Navy, between the radiotelegraphic stations at Spezia, and confirmed the theory of the system. They showed that it was possible to communicate between two stations equipped with the new system, at a distance of about 4 kilometres while another placed to the side of the line, joining them at 500 metres distance did not succeed in intercepting a single signal; and no disturbing influence from the Marconi apparatus was observed.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable; that coal may absolutely be removed from the ranks of necessary commodities; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

THE IMPORTANCE OF ELECTRO-CHEMISTRY
As bearing on the Electrical Industry. . . . .

By SHERARD COWPER-COLES, M.I.Mech.E., A.M.I.C.E.

⁂

ELECTRO-CHEMISTRY is now generally regarded as a science apart from electricity and chemistry, although there are a few who are opposed to electro-chemistry being made a separate science on the grounds that in modern times there is too great a tendency to specialize.

Dr. Swan, in his presidential address delivered to the members of the recently formed Faraday Society, a society started to promote the study of electro-chemistry, stated that the scope of electro-chemistry is so immense as to defy the utmost energy to fully occupy it; so far there is only a point here and there that has been touched, the labourers are too few, but the promise of reward in the discovery of new knowledge, and in the creation of industries, is great. The growing activity in the electro-chemical world has manifested itself in America and Germany by the formation of separate societies to foster this new and promising field of investigation, and in England a similar society has recently been inaugurated, appropriately called the Faraday Society, which has started work under very favourable auspices, with a roll of members some 300 strong.

Electro-chemical and metallurgical processes are rapidly taking the place of processes which are .purely chemical or metallurgical, and new developments are being recorded in the technical press at very short intervals; some 200,000 h.p. are employed in the electro-chemical industries. To but briefly review the work of the last few years would occupy many pages, which at present are not available for such a purpose. Many of the most important industries have been revolutionized or are being revolutionized by the application of electrolytic methods. In order of importance, from an industrial standpoint, the copper industry ranks first, both in priority of date and priority of magnitude. The world's total output of electrolytic copper, twenty to twenty-five years ago did not exceed ten to fifteen tons a week. In 1881 to 1882 this amount was probably increased to about sixty tons, as the result of the refineries erected in Swansea. During the next four or five years several of the American refineries got to work, and by this time, say 1888 to 1890, the world's total production was probably not more than 280 to 300 tons per week. Since that date, up to the present time, many refineries of gigantic size have come into existence, not only in America, but in England, France, Germany and even Japan. Figures recently published show that the United States produce electrolytic copper at the enormous rate of 278,860 tons, which, at £52 per ton, is worth £14,500,728 annually. The by-products secured daily, contain about 74,100 ounces of silver and 948 ounces of gold, which equal annually over seven million ounces of silver, valued at £2,600,000, and some 346 ounces of gold, valued at £1,430,447.

In addition to the vast industry of electrolytic copper refining, there are a number of minor industries where copper is deposited by electrolytic means for a variety of purposes, such as the production of copper tubes, cylinders and sheets, and for coating iron for protective and ornamental purposes. The coppering of iron rolls for printing purposes is an industry of some magnitude; amongst the smaller applications may be mentioned the coppering of iron rams for hydraulic machinery, barrels of machine guns, electric light carbons, zinc plates for roofing purposes. The electrotyping industry employs a number of hands. Great improvements have been made in the process of late, and the time originally required to produce a good copper shell suitable for printing purposes, which was some eight to twelve hours, has now been reduced to minutes. Under this heading may also be mentioned the producing of metallic parabolic reflectors, such as are being used by the War Office for coast defence, produced by depositing copper on a silvered glass mould or matrix, and expanding the deposited metal from the mould by the application of heat.

Calcium carbide is the next largest branch of the electro-chemical industry, the European production being over 60,000 tons per annum, and works exist capable of producing double this amount when the demand increases.

The electrolytic alkali and chlorine industry, embracing the production of caustic and carbonated alkali and of bleaching powder, hypochlorites and chlorates, comes next in importance, some 50,000 h.p. being employed in Europe alone for producing these products.

Aluminium next claims mention, the metal being entirely made in the electric furnace, which has superseded all chemical methods, the production of aluminium, at the present time, being estimated at over 6,000 tons per annum. The total water power controlled by one Continental company alone amounts to 27,000 horse power, the greater part of which is in use for the production of aluminium in the electric furnace. Sodium is manufactured by hundreds of tons by electrolytic means.

The recovery of zinc from zinc residues and its ores is being practised by Messrs. Brunner Mond, who are producing electrolytic zinc of exceptional purity, and experiments are being made to ascertain if the electric arc cannot perform the duties of the zinc distillation furnace in a more economical manner. The electro-deposition of zinc on iron has become a large industry, being practised in most shipbuilding yards.

The refining of nickel by electrolytic means is carried on at Sudbury, Canada, and is of great commercial importance. The nickel is deposited on thin nickel cathodes from crude nickel or matte; in other cases the nickel, copper and iron contained in the ore are brought into solution, and the metals are recovered by a series of electrolytic operations. The nickel plating industry is one of considerable magnitude and its field of application is increasing daily.

Ferro-silicon and ferro-titanium, chromium and its alloys are now being produced in large quantities, and employ some thousands of horse power.

Steel production in the electric furnace is being successfully conducted in Italy, France and America, and steel of excellent quality has been produced; the field will probably be limited to the highest grade steels and to those localities where water power and consequently electricity are cheap, and coal and coke dear.

A process for electrolytic lead reduction is at work at Niagara for the manufacture of litharge, white lead and lead peroxide, direct from galena or lead sulphide. Bullion is refined in Germany and America by electrolytic means, over 100,000 ounces of silver being refined daily in one installation in America alone.

Gold recovery from cyanide solutions by electrolytic means is making good progress. It has been estimated that some 88,000 tons of tailings and 46,000 tons of slimes were being treated monthly in the Rand by one electrolytic process alone, before the breaking out of the war. Carborundum, a substitute for emery, is produced at the rate of 15,000 tons a year at Niagara.

Tin is being recovered from tin scrap in several large works on the Continent; tin is also refined by electrolytic methods, and experimental works are now in operation in England for smelting tin ores in the electric furnace.

Phosphorus is now almost entirely made in the electric furnace, plants being in operation in this country, America and France.

The application of electrolysis to organic chemistry, for the production of such substances as iodoform, aniline blue and black, alizarine, Congo red, sulphuric acids, etc., is becoming an important field, and is receiving considerable attention.

The fixation of atmospheric nitrogen has been accomplished at Niagara, on a practical scale, and Darling's process for the manufacture of sodium and nitric acid from Chili saltpetre may prove of great industrial value.

At the present time considerable attention is being given to the purification of water by means of ozone, and several installations are at work on a commercial scale.

Experiments are also being conducted on a practical scale to determine if glass cannot be made more economically in an electrically heated furnace. Two works are now in operation, one in the Tyrol and the other in Westphalia. The production of barium and calcium by electrolytic means, will probably have far reaching effects in the near future.

The fusion of quartz in the electric furnace and the production of quartz vessels for chemical and metallurgical operations is likely to become an important industry.

Enough has been said to show what rapid strides are being made in the electro-chemical world, and it is to be hoped that more workers will enter this promising field, and that many more of the purely chemical processes will be superseded during the present century by the more cleanly and healthy electro-chemical process, and that manufactories will not always be associated with smoke, clamour and ugliness. It is to be regretted that so little encouragement has been given to this branch of the electrical industry by adequate endowment, to enable original scientific research, which is so essential to new knowledge, to be prosecuted with greater vigour.

❧

Electrophysical Research.

By G. W. de TUNZELMANN, B.Sc., &c.

ELECTROPHYSICAL research has been extremely active during the past year. It has tended very largely to centre itself in the investigation of the various forms of radiation arising out of Röntgen's discovery of the rays named after him, and especially in what is known as radio active radiation. The development of the electron theory, and of the associated electro-chemical ionisation theory, occupy a large part of the remaining field.

These subjects are very closely correlated with each other, and with other subjects which have attracted the attention of investigators, and perhaps the most salient feature of present electro-physical, and indeed physical research generally, is its tendency towards unification, especially in the more recondite branches.

During the earlier portion of the last century the tendency was towards increasing specialisation. Great masses of detailed information were accumulated, but general theories were comparatively few. During the latter half of the century a great change came over the scene. The development of the theory of the conservation of energy paved the way for the generalisations of thermo-dynamics, and for Maxwell's unfolding of the theories of the electro-magnetic field, and the electro-magnetic theory of light, born in the great mind of Faraday, but in a form which it required the genius of Maxwell to grasp. Even Maxwell's work remained unappreciated outside his own country, except by a few of the greater minds, until Hertz's beautiful investigations furnished incontrovertible experimental evidence of the truths embodied in the Faraday-Maxwell theories, and directed the hitherto scattered energies of hosts of workers towards the line of progress which they opened up.

The result is seen in such grand generalisations as the electron theory, which is becoming more firmly established every day, as fresh evidence accrues of its far reaching applicability, and one difficulty after another is shown to be explicable in accordance with it.

This theory has inspired with new life and new signification the old conceptions of positive and negative electricity, which at one time appeared to be dead and buried for ever, and at the same time it has entirely inverted the old ideas as to the relative knowableness of matter and ether. It used to be held that matter, which we could see and feel, was something simple and comprehensible in comparison with the mysterious unknown entity called electricity. Now, on the other hand, we have learned to regard the ocean of ether which fills the whole visible universe, as the ultimate simplest entity. The positive and negative electrons are considered to be the simplest kind of singularity, of differentiation from the surrounding ether, that can possibly exist, and very probably differing one from the other no more than one extremity of a twisted wire differs from the other.

Material atoms, once supposed to be indivisible and indestructible, we have learned to regard as complex structures, built up, even in the simplest cases, of many hundreds of electrons, so small that the space filled by them, compared with that of the atom, is, in all probability, less than that which would be occupied by a swarm of a few hundred gnats in a great cathedral, compared with the whole space contained within the building.

We know, as yet, practically nothing about the internal arrangement and movement of the electrons within an atom, except that they are in rapid motion. There appear to be, however, strong reasons for believing that atoms are built up of layers or strata, one within the other, composed alternately of positive and negative electrons; also that the external layer consists entirely of negative electrons, and that no passage of electrons takes place from one layer to another, except when the atom is undergoing disintegration. Some of the most recently observed phenomena of radio activity appear to afford considerable evidence of such disintegration, accompanied by liberation of positive electrons, in the case of some at least of the most complex atoms known to us, and each of which would contain hundreds of thousands of electrons. In the only case in which such disintegration has been actually demonstrated, *viz.*, in the discovery by Ramsay and Soddy of the degradation of radium into helium, the transmutation has not been that of a complex atom into one slightly less complex, but that of one of the most complex of known atoms into one of the simplest.

Such degradation must necessarily be accompanied by the evolution of heat, and this phenomenon was discovered by M. and Mme. Curie considerably anterior to the direct experimental demonstration, referred to above, of the transformation of highly complex atoms into much simpler ones. Prof. J. J. Thomson had, however, previously proved, by an indirect experimental method, that the observed evolution of heat could only be accounted for by disintegration of the radium atoms.

Although there are good reasons for believing that this disintegration would maintain the observed rate of heat evolution for many thousands of years, such evolution certainly indicates some limit to the life of any atom giving out radio active emanations. There is reason to suppose that these emanations are given out to some extent by all atoms, and, if this is so, every atom must have some maximum life period, which will be greater the smaller its radio activity.

It is difficult to use the expression life period, as applied to atoms, without ideas arising in the mind analogous to those evoked by Prof. J. C. Bose's researches on electrical response in living and non-living matter, which were completed in 1902.

The startling discovery by Bohn, referred to in the following notes, of signs of parthenogenetic development of ova submitted to the action of radium emanation, will, if confirmed, afford another indication that the insurmountable barrier, which was formerly supposed to exist between living and non-living matter, is nothing more substantial than a dark cloud which has hitherto obscured our vision of the borderland, and is destined to disappear before the ever-increasing power of the lamp of scientific research.

Industrial Electro-Chemistry and Electro-Metallurgy.

By J. B. C. KERSHAW, F.I.C.

ALUMINIUM.

REFERENCE.—Zeits. f. Elektrochemie, Nov. 19, 1903.

THE most striking event of the past month in relation to the aluminium industry has occurred in America. Judgment has at last been delivered in the United States Court of Appeal in the protracted litigation between the Electric Smelting and Refining Co. of Cleveland, and the Pittsburg Reduction Co., relating to the validity of the Bradley patents. These patents, after lengthy trials in various courts of the United States, were held to be the property of the Electric Smelting and Refining Co. of Cleveland, a company with which the well-known Cowles Bros. have been closely connected.

After this decision, infringement proceedings were commenced against the leading companies, who were using electric furnaces at all similar in design to those covered by the Bradley patents, and in each case the Cleveland Co. has won. The Bradley patent claims, according to this latest judgment, cover all furnaces in which the current is used for resistance heating, and as this is the manner in which the electrolyte is kept fluid in the Hall aluminium process, the Pittsburg Reduction Co.'s method of aluminium production is held by the Judges of the Appeal Court to be an infringement of the Bradley patents.

The judgment in this latest case contains some interesting details relating to the operation of the Hall process at Niagara. The baths are stated to be connected in series, and each holds 204 kgs. of the electrolyte. The carbon anodes are 7·5 cm. in diameter, and in order to start the bath when all is cold, the anodes and the carbon lining of the bath which functions as cathode, are brought into contact. The mixture of cold raw materials lying on the floor of the bath is heated to melting at the points of contact of anodes and cathode, and the further liquefaction of the materials, which go to form the electrolyte, then occurs by the resistance heating of the fluid covering the ends of the anodes. Aluminium fluoride, sodium fluoride and fluor-spar are used to form the electrolyte, but the proportions are not given in the judgment we are quoting. The Hall patent, which is valid so far as it relates to the composition of the electrolyte, runs in U.S.A. until 1906—while the Bradley patents covering the method of heating employed in the process, run some years longer. The manufacture of aluminium in the States will not, therefore, become an open industry for some few years, and it will be of interest to see what arrangement is made between the Cleveland and Pittsburg Companies, for protecting their respective interests, as disclosed by this latest judgment. The value of a long purse, and of infinite patience in patent litigation, has rarely been more strikingly exemplified than in this latest case across the Atlantic; for the Cleveland Co. is certain to gain many thousands of pounds, by the recent judgment in their favour.

ELECTROLYTIC ALKALI AND BLEACH.

REFERENCES. { El. Review, Oct. 13, 1903.
Nov. 13, 1903.

The fall in the value of bleaching-powder which marked the collapse of the agreement between the various producers, in the latter part of 1902, has had a marked effect upon the financial statements presented to the shareholders in some of the companies during the autumn of 1903.

The agreement between the Le Blanc and Electrolytic manufacturers had controlled production and price, and with its collapse bleaching-powder fell nearly 45% in value; or from £6 5s. 0d. to £3 15s. 0d. per ton. This loss of £2 10s. 0d. per ton, on the product which earned them their chief profits, was bound to have an unfavourable effect upon the balance-sheet of all the companies, and those that have, up to the present date, published their accounts for any portion of 1903, show a severe shrinkage in profits.

The Electrolytic Alkali Co., working the Hargreaves-Bird process at Middlewich, Cheshire, can only show a net profit of £483 for the year ending August, 1903, and both ordinary and preference dividends are passed. The Castner Kellner Alkali Co., working the Castner mercury process at Weston Point, have published an interim dividend notice, stating that the profits for the first half of their financial year (ending in Sept. 1903) will not permit them to distribute the usual interim dividend on the ordinary shares.

In view of these two statements by the English Electrolytic companies, the publication of the annual report of the United Alkali Co. of Liverpool, which pratically controls the English production of bleach by the old Le Blanc process, will be awaited with interest. This company, with a share capital of £6,000,000, has so far managed to pay 7% annually to its preference shareholders, although nothing has been paid on its ordinary shares for many years. It is probable that the striking fall in the value of bleaching powder which has marked 1903, will necessitate a reduction in the amount paid to the preference shareholders. The financial year of this company ends on Dec. 31st, and the report is due in March 1904.

Abroad, the electrolytic alkali companies are equally badly hit by the low price at which bleaching powder is now selling, and in some cases, the works have been shut down until financial prospects improve. It would therefore seem probable—as all the producers are suffering by the fall in value of one of their chief products – that the agreement concerning the regulation of production and price will be revived; and probably, early in 1904, some information will be published to that effect.

Post-script.—Since the above was written, a statement has been published in the *Manchester Courier* to the effect that this prophecy is already fulfilled, and that the convention has been signed.

ELECTROLYTIC HYPOCHLORITES.

References
Elektrochem, *Zeits*, Oct. 1902.
" " Nov. 1903.
" Engineer, Feb. 13, 1903.
Zeits. f. Elektrochemie, July 16, 1903.

The fall in bleaching powder has hindered developments in the electrolytic hypochlorite industry, for with bleach selling at £3 10s. 0d. or £3 15s. 0d. per ton, there is little inducement for manufacturers to erect plant for producing sodium hypochlorite for bleaching purposes, by electrolysis. However, the price of bleaching powder is not likely to remain at the low level touched during 1903, so that those interested in cells or apparatus for the production of bleaching solutions by the electrolysis of brine, may hope for a revival of interest in their inventions shortly.

The cell patented by the *Elektrische Bleicherei Fabrik* in Pfronten (Bavaria) is a striking departure from the usual designs. The electrolyte is made to flow over ribbed ebonite plates, and the electrolysis occurs in the narrow channels, by means of platinum wire electrodes of ▾ shape; the idea being to reduce the cathode area, and thus lessen the reduction due to nascent hydrogen at its surface. The efficiency of this new type of cell is stated to be unusually high, and 5 K.W. hrs. are said to produce 1 kg. free chlorine, with a consumption of 6 kgs. salt.

The Atkins hypochlorite cell, another new one, possesses as its essential feature, a semicircular wooden trough in which a cylinder covered with lead revolves. The trough is lined with carbon-blocks, which function as anode, while copper brushes collect the current from the axis of the revolving lead-covered cylinder. The space separating the cylinder and trough is only half an inch, and this is filled with a 10% solution of common salt. The cell is stated to yield good results, but no figures have been published for the yield of chlorine. A company named "Oxychlorides" Ltd., with a capital of £100,000 has been floated in London, to exploit the Atkins cell.

The Haas and Oettel hypochlorite cell, which is characterized by the use of secondary electrodes of carbon, has been *redescribed* in a recent article (see 2nd reference above). Little information, however, is added to that published three years ago, concerning this cell.

Foerster and Müller have been investigating the action of the addition of calcium chloride, calcium hydrate and resin to the electrolyte, as recommended in Schuckert & Co.'s patent No. 141,372 for hypochlorite production. A film of resinate of lime, is stated in the patent, to be formed over the surface of the cathode, and reduction of the hypochlorite by nascent hydrogen is thus avoided. The yield obtained under these conditions is said to rise as high as 33·5 g/l chlorine, as compared with a maximum yield of 23 g/l chlorine, when a chromate is used for a similar purpose. Foerster & Müller confirm the effect of this lime compound, but state that the efficiency of the cell suffers in the attempt to obtain high strength bleaching solutions.

NOTES ON SOME OF THE PRINCIPAL ADVANCES IN ELECTRO PHYSICS, PUBLISHED DURING 1903.

RADIO-ACTIVITY.

E. RUTHERFORD, continuing his researches, showed that excited radioactivity is one of the properties of the emanation from Thorium and Radium, and that it was due to matter deposited from the emanation. He also found that the radium emanation included : (1), heavy positively charged particles ; (2), negative electrons, as occurring in kathode rays ; (3), a third kind of radiation of greater penetrative power and incapable of deflection by a magnet.

In collaboration with F. Soddy, he found that the radio-activity of thorium decays much more rapidly than that of radium. They further discovered that the emanations from radium and thorium consist of vapours, which are condensed at the temperature of liquid air. The boiling points were found to be — 120°C. for the thorium emanation, and — 150°C. for the radium emanation.

F. Soddy and Sir William Ramsay observed that the vapour obtained from radium emanation, and sealed up in a tube, gave some of the spectral lines of helium after three days, although no helium was present originally. The complete spectrum of radium then rapidly developed.

J. Patterson observed a spontaneous ionisation of air, apparently due to radio-active emanation from the metallic walls of the containing vessel.

H. Becquerel suceeded in shewing that the emanations from uranium contain negative electrons only ; those from polonium, positive electrons only ; while both are present in the emanations from radium and thorium.

W. Wien obtained a current of 0·03 amperes from a tube containing four milligrammes of radium, evidently due to positive electrons isolated in the tube, owing to the radiation of negative electrons through the tube walls. E. Dorn, when opening a tube 0·3 millimetres in thickness, by scratching it with a file held in one hand, while the other hand held the tube, noticed an electric spark which pierced the tube he had begun to file.

E. van Aubel found that the conductivity of selenium is increased by radium emanation, and A. Becker observed a similar effect with various insulators. P. Curie had previously shown that this was the case with liquids, and it has long been known to hold good for gases.

J. J. Thomson found that radium enclosed in a cavity in a block of ice melted the ice. This disproves the Maxwell sorting demon theory that the energy was obtained from the air, and left no explanation except disintegration of the radium atoms to explain the continuous heat radiation observed by Curie and Laborde. He showed that an atom, assumed to consist of one positive and one negative electron, separated by so small a distance as 10·8 centimetres, would possess sufficient intrinsic energy for the diminution of this distance by 1 per cent. to obtain the observed heat radiation from radium for no less than 30,000 years.

C. P. R. Wilson found radio-activity present in snow, as he had formerly shown it to be in freshly fallen rain. J. J. Thomson found a radio-active gas, which could be driven off by boiling, in ordinary Cambridge tap water, and in the water from several artesian wells ; and R. J. Strutt obtained radio-active gas by passing air over hot copper, and by allowing it to bubble through either hot or cold mercury.

In July W. E. Wilson suggested that the existence of radio-activity in the sun might greatly extend the limits previously assigned, from thermo-dynamic considerations, to the past life of the sun, and G. H. Darwin showed that the presence of a comparatively small percentage of radium would be sufficient to extend this to the utmost limits demanded by geologists. J. Joly showed that the apparent absence of those emanations from ordinary sunlight could be accounted for by atmospheric absorption, and that, owing to this cause, they would probably not be observable, even if the whole heat energy of the sun were due to radio-active disintegration.

G. Bohn, continuing his biological researches on the effects of the radium emanation, experimented on a large number of hedgehog ova, and while he found that the spermatozoa were killed by the emanation, he obtained a startling and most extraordinary result in the case of unfertilized ova, about 3 per cent. of which showed signs of parthenogenetic development under its influence.

BLONDLOT'S N RAYS.

R. Blondlot, in the course of researches on Röntgen rays, obtained confirmatory evidence of their consisting of irregular impulses ; as he found that rays greatly differing in penetrative power all had the same velocity, which was independent of the medium. He further succeeded in polarising the rays, and in obtaining, by means of sugar solutions and of quartz, a rotation of the plane of polarisation.

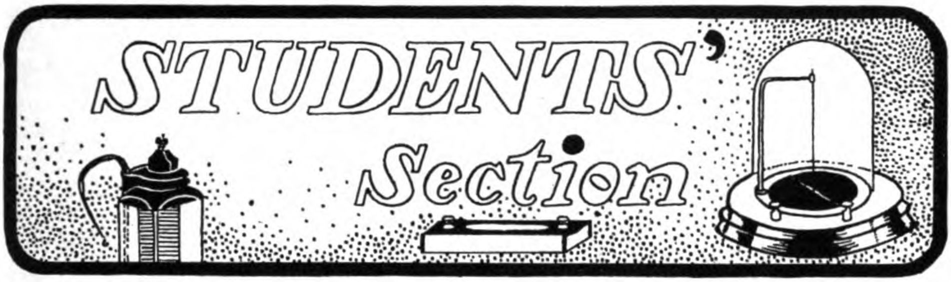
Continuing his researches, he discovered a new group of rays, to which he gave the name of N rays, owing to the researches having been made at Nancy University.

These rays are polarised when emitted, are subject to refraction and reflection, penetrate aluminium, black paper, and wood, like Röntgen rays, but show no trace of fluoresent or photographic action. They were found to be present in the light from an Auer burner, from a circular gas flame burning without a chimney, and in the radiation from hot silver, talc, and other substances. They were found to penetrate hot platinum, though stopped by the cold metal.

The author's latest discovery is that a dimly luminous object may be brightened by N rays falling upon the eye, and not upon the object in question. He considers that these latest researches afford reasons for believing these rays play an important part in the economy of animal and vegetable life.

* * *

Sir David Salomons, Bart., M.I.E.E., &c., writing to the Editor-in-Chief of *The Electrical Magazine*, says : " The journal will meet with general approval, since to obtain information at present a mass of reading has to be gone through to sift out a few facts occupying but a page or less."



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of THE ELECTRICAL MAGAZINE feels that something more is wanted, and the Associate Editors, will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

INTRODUCTORY ADDRESS.

By Professor ALFRED HAY, D.Sc., M.I.E.E.

In a new electrical magazine which has a special section devoted to the interests of students, it may not be out of place to offer a few introductory remarks addressed to its student readers.

Electrical engineering is so intimately connected with electrical science, that an electrical engineer who possesses no scientific training is not only an impossibility, but an absurdity. In no other branch of industry are theory and practice more closely in touch with each other, nor is the progress of the one more intimately bound up with that of the other. Scores of instances might be mentioned in which a discovery in pure electrical science has led to important practical applications, and others in which some effect which could only be conveniently observed or become sufficiently prominent when displayed on a large engineering scale, has led to most interesting researches in pure science. In no other instance has the law of action and reaction between theory and practice been more forcibly demonstrated.

An electrical engineer, then, must, above all things, be a man of science, and, in the solution of the many difficulties which confront him, must be guided by scientific methods. But the possession of the kind of scientific knowledge which will enable him to cope successfully with the most pressing problems of his profession can only be acquired by long and patient study, and this study must be maintained uninterruptedly if he would keep abreast of recent progress. In this sense, every leading electrical engineer must also be an earnest student of electrical science. But in the "Students' Section" of *The Electrical Magazine* a special effort will be made to minister to the needs of those junior members of the profession who are still battling with the many difficulties that no longer trouble their senior and more experienced colleagues. It is needless to point out that the hopes of the electrical engineering profession necessarily rest on its junior members: they are the leaders of the future, and it rests with them to maintain the honour of their country in advancing, by strenuous and unremitting effort, the progress of a branch of engineering which owes so much to the genius and energy of British men of science.

It might, perhaps, be thought that nowadays, when the opportunities of acquiring knowledge, either by attendance on classes or by the reading of text books, are so numerous and within such easy reach of even the humblest, a "Students' Section" in an electrical magazine is somewhat of a superfluity. A moment's consideration will, however, show the fallacy of such a supposition. It is only the careless student who never encounters any difficulties, for the simple reason that he never gives sufficient thought to the subject of his study. To the earnest and thoughtful student, numerous difficulties are bound to occur—difficulties which could never be dealt with quite satisfactorily within the narrow limits of a text-book or a lecture. It is to such earnest students that the "Students' Section" will be addressed, and it is hoped that in this way a considerable amount of helpful and stimulating information may be imparted to the student readers of *The Electrical Magazine.*

The Editor, therefore, earnestly appeals to the readers of this Section for support in making it as interesting and useful as possible, by sending him either questions or statements of any difficulties they may come across in their studies. Any reader who wishes to take advantage of this invitation may rest assured that his enquiries will receive careful attention. It is found that occasionally a student who experiences a real difficulty has a certain amount of diffidence in stating it, because he has an uneasy feeling that his question may involve an absurdity, and may compromise him. No fear of this kind, which in nine cases out of every ten is quite groundless, need deter any reader of this magazine from sending a statement of his difficulty, as his identity would, of course, remain concealed. And so, in the hope that our student readers will help to make their own section of the magazine as great a success as it deserves to be, we bid them a hearty welcome.

◆ ◆

THE TRAINING OF APPRENTICES.

◆

AN interesting article, in a recent issue of *The Engineering Magazine*, which may have escaped the attention of our student readers, is worthy of notice here as bearing directly upon the methods of a large manufacturing firm in dealing with its apprentices. The author, Mr. C. E. Downton, treats with the system developed by the Westinghouse Electric and Manufacturing Co., Pittsburg, in its enormous electrical engineering shops, a "pocket edition" of which, if we are to credit the comparison, is now operating at Trafford Park, Manchester. Prior to the year 1896, no systematic method was in vogue, and both technical and non-technical graduates were treated alike in passing through the shops. Subsequent developments consequent upon the extension of the works and the increase in the number of apprentices saw the formation of a separate department, which kept track of the student's welfare, with better results to both parties.

Two distinct courses are now adopted—one for non-technical and the other for technical graduates.

The first, the "ordinary apprenticeship," provides for intelligent young men desiring to learn the machinists' trade. The company develops the best of these into skilled mechanics, foremen, and inspectors, giving each man a specific training in that definite line, for which he shows the greatest aptitude. Through the various stages of his training, his association with every class of machine in his particular branch fits him for any responsible position which can be filled by a skilled mechanic. A three months' trial is required before the apprentice becomes indentured, the minimum age being 17 years. Pay ranges from 5 cents per hour in the first year to 15 cents in the fourth year, time and a half being paid for all overtime.

The second course, the "engineering apprenticeship," of two years' duration, provides for graduates of technical schools and universities, great care being taken in their selection, while the co-operation of professors is solicited, and their recommendations given due consideration before encouragement is given any applicant.

In this advanced course, as well as spending about one half his time in the shops, the pupil enters also the construction, testing, and correspondence departments; in fact, becomes familiar with the latest engineering practice. Constant vigilance is exercised to discover exceptionally appreciative workers, and a young man can readily prove his worth and receive commensurate compensation at the hands of the Company. The course is so conducted that experience in the testing department, which deals with apparatus for shipment, is acquired at the end of the training, as an apprentice can then better understand the details of the machine he is required to pass as correct. Familiarity with constructional particulars will frequently enable a man to avoid premature testing, by pointing to some fault in the assembling of the parts.

A daily report is presented to the foreman in charge of the department by each apprentice, through his particular shop foreman, and these reports form a concise and handy record of the work of individuals, while readily prompting the selection of men for such positions of responsibility as may be vacant.

A common interest in the work among the apprentices has become crystallized into the formation of "The Electric Club," an organization distinct from the company itself, though mostly supported by the members of the management, engineers and apprentices, of the Westinghouse Electric and Manufacturing Co.

The local section of the American Institute of Electrical Engineers, meets once monthly in the club room, and club members in return for the privilege, are invited to participate in the discussions. The assembly hall has a seating capacity of 250 persons, and in addition there are seven other rooms, used chiefly for class and section meetings.

We understand that the British Westinghouse Co., Trafford Park, Manchester, have a somewhat similar series of apprenticeship courses in vogue at their works, but presumably they have not yet developed them to the same degree of perfection as their *confreres* across the water. Matters are by no means at a standstill, however, and already an engineering society has been formed, at whose meetings papers of interest are read. We shall hope to give fuller details of this interesting branch of an equally interesting manufacturing establishment in succeeding numbers of the magazine.

MANUFACTURERS' Section

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be ***original*** and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

INTRODUCTORY ADDRESS.

By W. NOBLE TWELVETREES, M.I.M.E., A.M.I.E.E., &c.

In practically every sphere of electrical work, the general objects of this magazine are already known and appreciated. The issue of this, the first number, will serve to make clear in detail the scope of *The Electrical Magazine*, and to unfold the plan upon which it has been designed.

Conformably with the scheme of classification adopted throughout for the suitable and convenient presentation of matter specially appealing to those who are interested in different departments of electrical science, this section will be devoted exclusively to subjects with which manufacturers are particularly concerned. We do not profess that electricians, who are occupied in the industrial development of electrical plant and appliances, will find in the few pages comprised by this section anything like an adequate record of all the matters with which they must keep in touch month by month. To furnish a complete compendium of information on the progressive theory and practice of electricity is the function of *The Electrical Magazine* as a whole, and in its pages will be found everything that is needed by those who make it their business to apply the teachings of scientists in practical forms for the benefit of mankind.

This section will, accordingly, form a department of the magazine in which manufacturers may take a kind of proprietary interest, and to which they may turn for information upon current matters of industrial importance. They are also invited to contribute material for descriptive or other notes upon subjects of technical interest to their professional *confreres*; or to raise questions, or urge points, having for their object the advancement of British electrical industries.

Further, we shall present notes upon new inventions and current expressions of opinion as to the practical design, application, and installation of electrical apparatus of every kind. Recent types of machinery, instruments, and accessories, and new installations of plant, will be described in detail, so that our readers may keep themselves *au courant* with what is transpiring in the electrical world, without the labour of searching through numerous electrical journals and other publications.

We desire most particularly to emphasise the announcement that manufacturers are cordially invited to consider these pages open to them at all times for the expression of opinions and suggestions relative to the benefit of British electrical enterprise. Communications of this kind will always be welcomed, with the object of furthering the interchange of ideas between those whose daily labour is associated with the development of electrical science in a practical manner.

Early information relative to new electrical machinery, instruments, and plant, together with photographs, drawings, plans, diagrams, and records of tests, will be gladly received.

As our object will be to make all such notices of real value, the data furnished should be of an essentially technical character, and all drawings such that readers may be able to identify the salient features of the apparatus described. An expert member of our staff will be delegated to make personal inspection of new machinery and plant suggested for notice, so that all published descriptions may be universally recognised as possessing a thoroughly impartial and independent character.

The development of electrical practice in all the chief countries of the world will at the same time receive critical attention, and as far as possible our readers will be placed in a position to observe the latest movements of their foreign competitors. This feature of the section should be of the greatest value to the British manufacturers, to whose interests *The Electrical Magazine* is more particularly devoted.

In looking back upon the past few years, we must all feel satisfaction at the wonderful strides made in the development of electrical industries in this country. The popular impression that electrical plant of any importance must necessarily come from the United States or from Germany, has practically died a natural death, and confidence in the skill and competence of British manufacturers is thoroughly established. Nevertheless, we still suffer to a serious extent from foreign competition, and quite lately there have been noticeable instances in which foreign electrical plant has been adopted, most unnecessarily, to the exclusion of our own productions.

There appear to be only two alternatives by the aid of which the home market may be secured for British manufactures. One of these is the establishment of equitable trading conditions so as to ensure fair play to British industry, and the other is the progressive mprovement of our own electrical manufactures to such a pitch of perfection that they may be universally demanded, irrespective of price. The first of these alternatives belongs to the domain of fiscal legislation, a subject which is dealt with elsewhere in our present issue, and the other is one which we fully believe has long occupied the serious and continual attention of manufacturers. But in addition to advancement in the design and construction of electrical machinery it is extremely desirable that all such apparatus should be standardised to the fullest possible extent. The advantages to be derived from standardisation are no doubt admitted in a more or less theoretical sense, but we should like to see more evidence than exists at present that the principle commends itself in a practical way to those whom it will benefit most. Until meaningless variations of design can be abolished by mutual consent, it will always be difficult for prompt deliveries to be effected, and purchasers will still be tempted to buy from other nations which have practically adopted standard designs for apparatus in general use.

The Electrical Committee of the Engineering Standards Committee are doing a great work in connection with the design of electrical machinery and appliances, and the Institution of Electrical Engineers has already performed a much more important service by bringing together members occupied in different branches of the profession for the friendly discussion of the theory and practice of electrical science. In a similar, though necessarily in a smaller, way we hope that this section of *The Electrical Magazine* may be found of service by those to whom it is addressed. The successful realisation of this ideal depends very largely upon the co-operation of our readers, and with this, of which we feel already assured, the Manufacturers' Section will take the form of a small magazine exclusively devoted to the interests of engineers who are occupied in the necessary, and sometimes difficult, task of realising in practical form the teachings of abstract science.

◆

Whilst THE ELECTRICAL MAGAZINE will contain in each issue a number of high-class *original* articles by the leading electrical experts of both hemispheres, it will also comprise a feature which is absent from every other electrical paper in that it will be virtually an Electrical Review of Reviews, as it will contain in a classified form a practical digest of the best of the world's electrical literature. All the principal British, Continental, and American electrical journals, papers read before Learned Societies, and other literature, will be carefully searched, as issued, by a staff of experts, and the matter which is likely to be of the greatest interest and value to readers will be abstracted and incorporated into the various sections of THE ELECTRICAL MAGAZINE by the Associate Editors. Thus, the Magazine will save the busy man the necessity of wading through a mass of technical literature in order to sift the grain from the chaff, in which process, owing to the limitations of time at his disposal, he more often than not loses what he would most like to know.

THE FERRANTI INTEGRATING WATT METER. . . . . . .

By the introduction of the instrument here briefly described, we have a useful addition to the comparatively recent class of electricity meters, in which the principle of the induction motor is applied. Fig. 1 is a front view of the meter with the cover removed, and it will be seen that the energy is recorded directly on the dials in Board of Trade units. In the design of the instrument certain novel features are incorporated, by which excellent results are attained. The energy consumed on an alternating current circuit can be measured with great accuracy, whether the load is inductive or non-inductive, and while the precision of the meter is equal to that of many laboratory standards, it is essentially a practicable and serviceable instrument for every-day use.

Figs. 2 and 3 illustrate the general construction of the meter. An aluminium rotatable disc, D, mounted on the spindle, S, is geared to a train of wheels actuating the index hands of the dials, and serves the purpose of an armature, receiving the driving torque of the meter coils, as well as the retarding torque of the permanent magnets, P.M. One shunt coil, Sh.C., is placed round the core, C, of a tubular electro-magnet, T.M. The core of this magnet has three outward radial poles, P_2, alternating with four inward radial poles, P_1, from the shell of the shunt magnet, the planes of these being horizontal and parallel to the disc.

It is common knowledge that in a meter of the induction motor type, the shunt circuit must be very inductive, and with the object of securing this condition a special tubular magnet is used, which obviates the necessity for choking coils, secondary circuits, resistances, or compensating coils. The series system consists of a slotted armature, S.A, above the disc, the series coils, Se.C, being wound in these slots. A wave form of winding is used, somewhat similar to the winding adopted in the Ferranti disc alternator, and it will be seen that the slots of the series armature are almost directly above the poles of the tubular magnet.

The following consideration will serve to make clear the principle upon which this meter works. If the shunt circuit be sufficiently inductive, the eddy currents produced in the disc by the shunt field will be in phase with the impressed E.M.F. These eddy currents are acted on by the series field—which is in phase with the load current—giving a driving torque on the disc proportional to the E.M.F. of the circuit multiplied by amperes, and the cosine of the angle of lag of the main current behind the E.M.F., this being the power in watts supplied to the circuit through the meter. The retarding torque due to the permanent magnets is proportioned to the speed, and the disc therefore revolves with a speed proportional to the watts.

With the object of compensating for any want of symmetry in the magnetic system due to

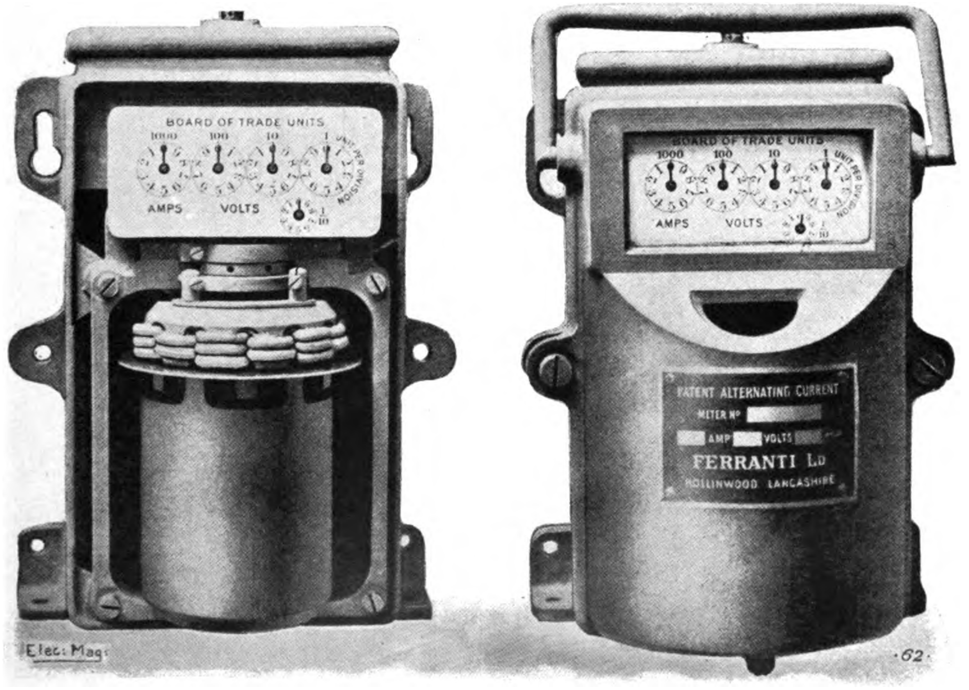


Fig. 1. The Ferranti Meter—Open and Closed.

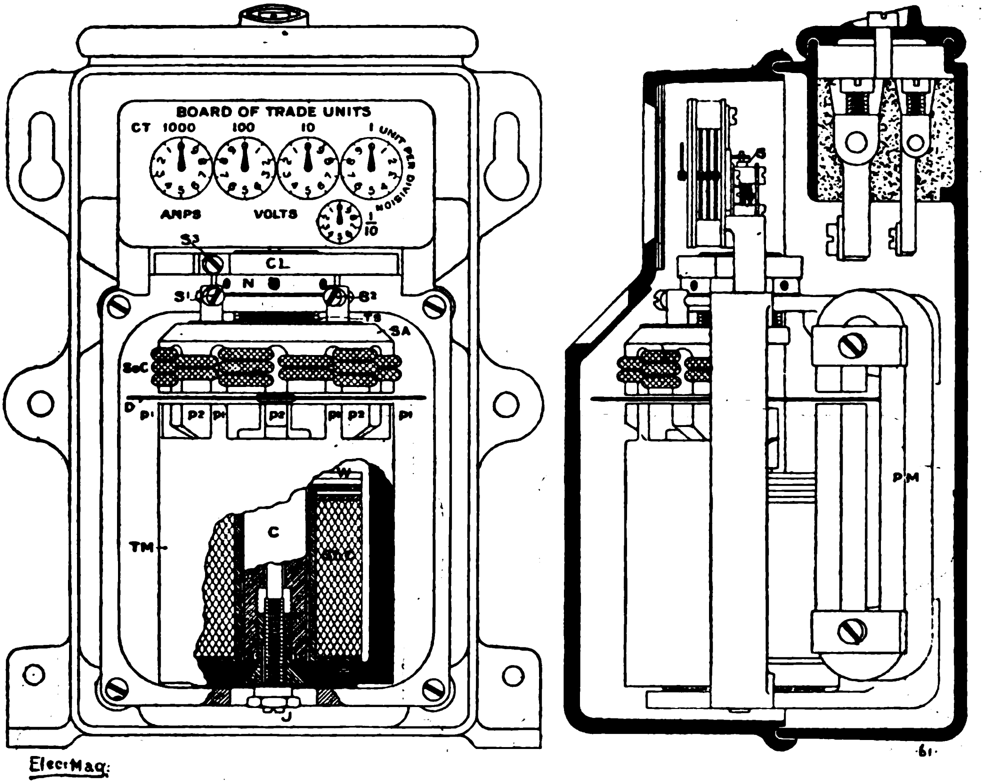


FIG. 2. THE FERRANTI METER—SECTIONAL ELEVATION. FIG. 3.

physical or mechanical irregularities in the material or workmanship, it is usual, in meters of similar type, to provide special grooves, pole extensions, coils, or other devices for the purpose of adjustment. For the Ferranti meter, however, it is claimed that nothing of the kind is necessary, as the required compensation can be obtained by simply turning the series magnet about the axis of rotation of the disc. Adjustment can be accurately performed by slightly altering the relative positions of the shunt and series magnets by means of the screws S1 and S2. The constant of the meter can be adjusted by raising or lowering the series armature by means of the nut, N, on the threaded spindle, T.S., the series magnet being fixed by the clamp, C1, and the screw, S3.

The meter is very accurate under all conditions of circuit on overloads up to 50 per cent., and with variations of voltage to 50 per cent. above or below the normal, and it is practically independent of variations in periodicity, wave form, or temperature.

In order to give some idea as to the starting current of this meter, it may be stated that a 10 ampere size will start with 0·05 ampere, and registers accurately with a 250 volt 8 c.p. lamp. With regard to efficiency, in a 10 ampere 200 volt 100 period instrument, the losses in the shunt circuit are not above 1·7 watts, and in the series circuit at full loads they do not exceed 0·8 watt.

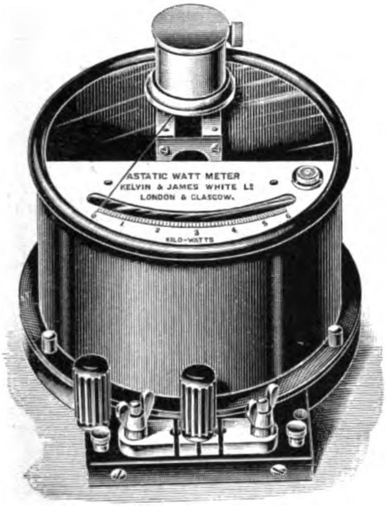
These figures are of some importance, and speak well for the performance of the instrument. All meters are adjusted to run at the speed of 40 revolutions per minute at full load, and as the speed of the disc is directly proportional to the load, it is easy to check the calibration of the meter at any time.

As will be seen by the illustrations, the meter is of simple construction. There are few electrical connections and no parts likely to get out of order. It is enclosed in a cast-metal watertight case fitted with rubber joints, and is arranged for double sealing by the supply authority.

* * *

AN ASTATIC WATTMETER.

THE question of accuracy in the measurement of power by wattmeters is one which has of late years been brought before engineers, and the alleged error has to a very large extent been magnified. If engineers would only state the conditions under which the wattmeter will require to work, there would be absolutely no difficulty in manufacturers supplying an instrument to fulfil their purpose admirably, but obviously it is not correct to assume that the instrument most suited for one purpose is the best for all purposes. In a wattmeter working on the dynamometer principle certain precautions have to be adopted if accurate results are to be obtained, but these are often omitted either for the sake of appearance or compactness in the instrument. For instance, most wattmeters consist of a single fixed coil acting on another movable coil, and although this instrument might be suitable for laboratory or test room work it is not correct to use the same instrument on a switchboard where there may be strong external fields. If approximately accurate results are to be expected reversed readings should be taken, and even this is necessary under all conditions when the instrument is used with direct current on account of the horizontal component of the earth's magnetic field. The type to be preferred for all work is one having an astatic system thus annulling all effects due to external fields. Instruments are sometimes fitted in metal cases, in which Foucault currents are generated, which in themselves cause errors. This difficulty can, however, be easily overcome by fitting the instrument in a case of non-conducting material.



Kelvin and White Astatic Wattmeter.

The question of the effect of wave form, periodicity and power factors on wattmeters has also occupied the attention of engineers, but the effect of these various factors has only to be considered in certain special work. In testing three phase motors, the Heyland diagram is now being more generally employed, and as results with it depend on the accuracy of obtaining the no load curve and static loss, the motor power factor being in neighbourhood of 0·2 or 0·3, the accuracy of the wattmeter in circuit is not always considered. The chief point is to keep the self-induction of the movable coils as low as possible so that the current in the shunt coils will at all times agree in phase with the potential difference between the mains.

We illustrate an instrument made by Messrs. Kelvin & James White, Ltd., embodying all these points, that is, the coils are arranged astatically and the instrument is fitted in a case of non-conducting material. The self-induction of the movable coils also has been reduced to a minimum, and the instrument can be relied on to within 0·5% when used on circuits having as low a power factor as 0.3 at all periodicities. As, however, the voltage is increased and the periodicity is reduced the accuracy is increased. In order to increase the range of the instrument the fixed coils are connected to contact blocks, and by means of plugs the coils can be connected in series or in parallel. The resistance in series with the movable coils is also sub-divided so as to give a more open scale when used on different voltages.

This instrument will be found to be of great use in testing motors, alternators and meters, and will supply a long felt want for a moderately cheap and yet accurate wattmeter. As will be seen, a milled head is provided for setting the zero, and a mirror is fitted on the scale below the pointer in order to obtain accurate readings.

* * *

ELECTRIC POWER CRANE.

A LARGE crane for hoisting materials from a height above the ground and depositing them within any point within reach of the crane and track upon which it runs was employed recently in Brussels during the erection of some barracks 73 ft. high and 220 yds. long. According to the *Elektrotechnische Rundschau*, the crane was of 10 tons capacity, and was fitted with three separately controlled motors, for hoisting and lowering, travelling and slewing. The wheels of the crane are not connected by axles, as a maximum clearance for materials deposited on the track was necessary. That part of the crane carrying the wheels was strengthened against transversal forces by using a track of double rollers, between which the wheel flanges could pass with relatively small play. By this means, the sleepers, as it were, are substituted for the missing axles. The crane can pass over stones and such building materials as are set down between the rollers, a clearance of 7½ ft. by 5 ft. being obtained. The gauge of the track

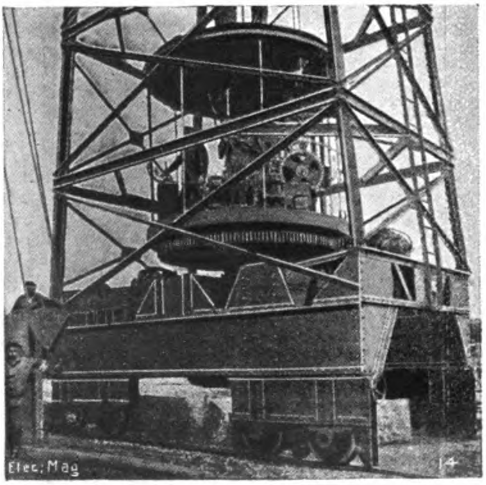


Fig. 1. Base of Powep Crane.

is 10 ft. $7\frac{3}{4}$ ins. and a length of some 200 yds. has been laid at the side of a narrow road, with a gradient of about 1 in 30. Forty-nine ft. above the ground the crane carries a small gallery, whence orders can be given and the work generally superintended. A vertical bearing fixed at that height serves to guide the crane arm when it revolves.

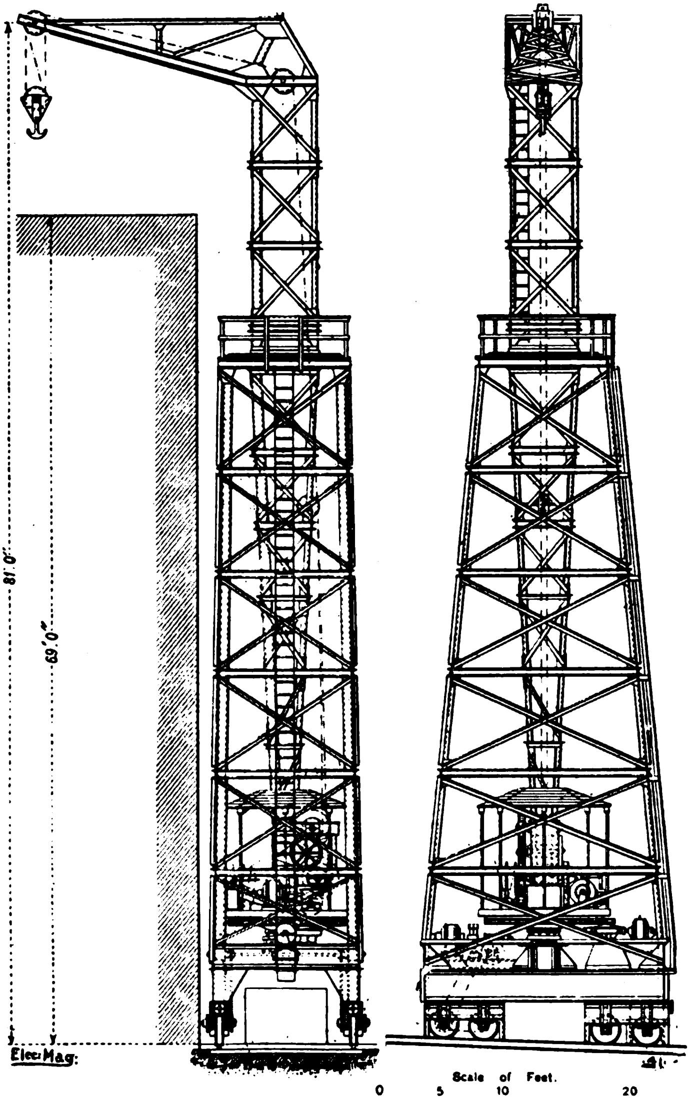


Fig. 2.—Electric Power Crane.

The control of all the crane movements is effected by one man from a platform at the base of the tower. The motors are protected against overload by automatic devices. The double lifting hook is provided with roller and ball bearings, as are also the guide and base bearings of the revolving part of the crane. Loads of 10 tons can be hoisted at a speed of 16 ft. per minute, and 57 ft. per minute can be attained with weights of 3 tons or less, while slewing can be performed at about 130 ft. per minute. It will be seen from the illustrations that the girder principle is employed in the building up of the crane. The entire construction can be easily dismounted and erected again where required. The first illustration depicts the construction of the crane at its base, the extreme width at this part being $12\frac{1}{2}$ ft. The crane has been built to the order of the Société Anonyme de Waele, Bruxelles, by the Gesellschaft für Elektrische Industrie.

* *

INDUCTION MOTORS.

*

Various types of induction motors have been devised, but the only one of practical interest is that in which the work is performed by the magnetic forces produced by the field due to a secondary current reacting upon the field produced by a primary current.

Both primary and secondary currents are necessarily alternating, as it is only by a change in one current that another can be induced. It is also necessary, in order to secure a continuous rotary motion, that the currents should be polyphase. This does not necessarily imply that polyphase currents should be supplied to the motor, although it is usually advisable that this should be done.

The elementary theory of induction motors is perfectly simple, but close examination of their behaviour involves the consideration of some complex relationships, and is correspondingly difficult. In fact, such a study can scarcely be made without the use of approximations affecting to a greater or less degree the accuracy of the results. Obviously the results of such a mathematical investigation are only correct to the same degree as were the original assumptions. It is, therefore, of the utmost importance to determine as accurately as possible the degree to which such approximations are likely to effect the final results.

An extended study of the induction motor, with especial regard to its engineering capabilities, is to be found in a thesis recently presented to Cornell University by Mr. G. L. Hoxie. In this

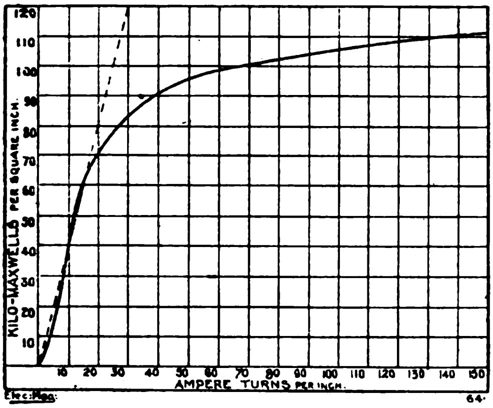


FIG. 1.

the author first makes careful study of a particular motor with the view of actually determining what goes on in the iron and copper of which it is composed. The motor chosen for this detailed study was one for which the writer was able to obtain nearly all the electrical dimensions, its specification being as follows :—

Horse power	75
Revolutions per minute	250
Outside d'ameter of primary core	40 in.
Inside ,, ,,	32·09 ,,
Outside diameter of secondary core	32 ,,
Inside ,, ,,	26 ,,
Gross laminations parallel to shaft	10·5 ,,
Ventilating ducts	1 ,,
Net laminations	9·5 ,,
Volts primary pressure	220
Phases	3
Poles	12
Primary connection	delta
,, circuits per phase	1
Number of primary slots	144
Dimensions of primary	0·36 by 1·6 in.
,, ,, conductors	1·00 ,, 0·6 ,,
Primary conductors per slot	4
Secondary connection	sq. cage
Secondary slots	99
Width of secondary slots	0·55 in.
Total depth of secondary slots	0·58 ,,
Secondary conductors per slot	1

The particular value of such study lies in the possibility that the results obtained may assist the formation of an idea of the reasonableness of customary approximations, and of the places where approximations may be freely used, and where only with great caution. The propositions assumed by the author are :—

(1) That all the reluctance of the magnetic circuits is contained in the teeth and air gap.

(2) That all parts of the magnetic circuits have a constant permeability.

(3) That no flux surrounds individual conductors, or conductor groups, locally.

(4) That the flux is entirely confined to iron, except at the air gap.

(5) That the conditions of the moment chosen are constant.

As none of these statements are strictly true, the following notes, abridged from the thesis, may be useful.

(1) The error in distribution due to the inaccuracy of assumption No. 1 is shown to be not greater than one due to a total change in the reluctance of about 10 per cent., and this change is practically the same by any path. The alteration in the distribution is therefore entirely negligible.

(2) The permeability of the air gap is, of course, constant. The permeability of the iron is nearly constant within a limited range, but is far from constant over a wider one. Assumption No. 2 may be quite incorrect in some instances, and the errors may be negligible in others. In Fig. 1 a straight line is drawn through the origin in such a way as to become an average of the magnetization curve for a portion of its length. If the magnetization curve and the straight line coincided, it would mean that flux density in the iron was proportional to the magneto-motive force applied to it. For any given density, the error involved in assuming the above to be true, is indicated by the horizontal distance between the two curves. It may be noted that the two curves practically coincide between the flux densities of 25,000 and 65,000 maxwells per square inch.

By reference to Figs. 2 and 3 it will be seen that, with trifling exceptions, the flux densities in the primary and secondary cores of the motor examined lie within those limits. The primary and secondary teeth belonging to the three outer paths, carry flux at a higher density than 65,000, and the immediate effect of the low permeability of the high density teeth is to reduce the flux about as follows :—

Path No. 1	5 per cent.
Path No. 2	4 ,,
Path No. 3	1 ,,

Such a change in the flux of these teeth would cause other slight changes, which generally may be disregarded.

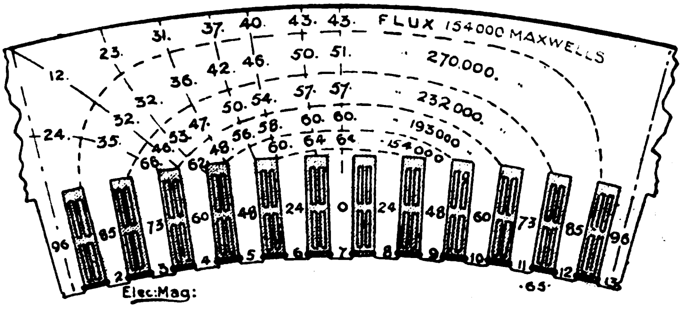


FIG. 2.

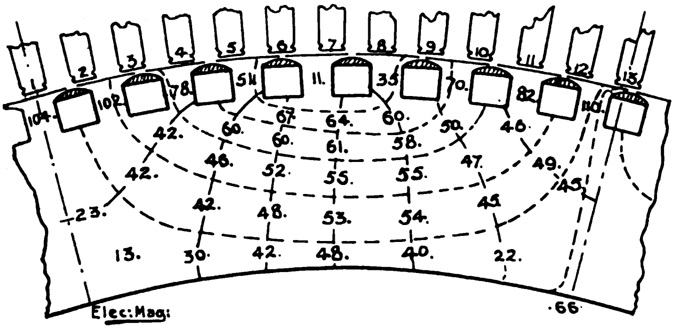


FIG. 3.

(3) Leakage flux may be divided into two parts.
(*a*) Complete flux path in non-magnetic media.
(*b*) Flux path partly in iron.

Flux as in (*a*) is found to be quite unimportant as compared to the total flux, but the flux partly in iron, as in (*b*), is a complex matter exceedingly difficult of analysis, and no very satisfactory method for predetermining this quantity is available without involving an amount of labour disproportionate to the results.

(4) The amount of flux that crosses through the non-magnetic substances lying in a slot depends principally upon the degree to which the iron of the neighbouring teeth is saturated. In the case of the motor here considered, the teeth densities are rather moderate, and a very small proportion of the flux crosses through any slot.

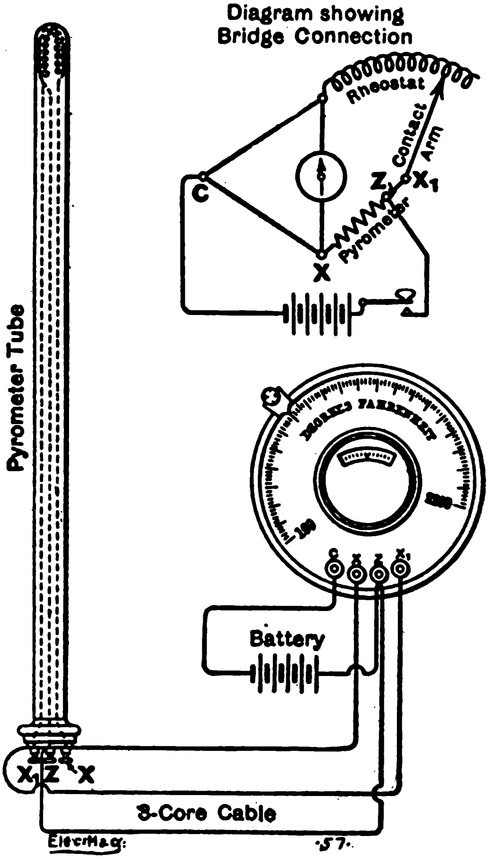
(5) At the moment chosen for investigation, the flux per pole has the greatest possible value and the flux in a single tooth at the centre of a pole is at maximum density. The approximations that have been made are therefore less close than at any other moment. The only other item for consideration is the shifting of the secondary structure resulting in changes of secondary-tooth density, for which a fair average must be taken. The condition of Figs. 2 and 3 probably represent a fair average, since they are favourable to a low density in the teeth at the left of the figures and to a high density in those at the right, both being for the same magnetic circuit.

So far the thesis simply deals with the behaviour of the magnetic circuit of a particular machine when an appropriate polyphase E.M.F. was applied to it. In conclusion, the engineering capabilities of the induction motors are specially considered, and to this part of the subject we will refer on another occasion.

* *

ELECTRIC PYROMETERS.

A PYROMETER, consisting of a coil of platinum wound round a cylinder of refractory material, and fixed usually at the end of a long closed iron tube, where it is protected by a platinum shield, is made by Messrs. Siemens, Bros., & Co. For measuring the resistance of coil to ascertain its temperature, two types of apparatus are used; one, comprising a differential galvanometer and a set of resistance coils, gives readings in ohms, and the temperatures corresponding thereto are ascertained by means of special tables. The other is a combination of a small D'Arsonval Galvanometer and Wheatstone Bridge, with a circular resistance and sliding contact, and gives readings directly in thermometric degrees. Both types are claimed to give very accurate readings. The chief field of application lies with iron, steel, and similar processes, the temperature of which has to be constantly observed and regulated. Tables appended to the pamphlet show that an increase in the coil resistance of an instrument of type No. 1 from 10 ohms to 44·9 ohms corresponds to a rise in temperature from 58° F. to 2,204° F. In the illustration the diagram of an instrument of the second type is given, which needs no explanation.



SIEMENS' PYROMETER DIAGRAM.

Standard Direct Current Pressures and Standard Frequencies.

One of the most important committees comprised within the extensive organisation of the Engineering Standards Committee is the Electrical Plant Committee. This committee, under the presidency of Sir William Preece, includes representatives of various Government Departments, and the leading consulting and manufacturing electrical engineers in this country. Since its formation some months ago, the constitution of the committee has been considerably altered, and the list of members printed below will probably be of interest to our readers, more particularly for the reason that it has not previously been published :

Sir William Preece, K.C.B. (Chairman).

War Office :
  Colonel H. C. L. Holden, R.A.
  Captain A. H. Dumaresq, R.E.
Admiralty :
  Commander H. W. Richmond, R.N.
  C. H. Wordingham, Esq.
  L. J. Steele, Esq.
Post Office :
  John Gavey, Esq., C.B.
Board of Trade :
  A. P. Trotter, Esq.
National Physical Laboratory :
  Dr. R. T. Glazebrook.
Colonel R. E. Crompton, C.B.
Major Philip Cardew.
W. A. Chamen, Esq.
Philip Dawson, Esq.
S. Z. De Ferranti, Esq.
Robert K. Gray, Esq.
Mark Robinson, Esq.
R. Percy Sellon, Esq.
Alexander Siemens, Esq.
J. F. C. Snell, Esq.
Charles P. Sparks, Esq.
James Swinburne, Esq.

Leslie S. Robertson, M.Inst.C.E.
(Secretary).
C. Le Maistre, A.M.Inst.E.E.
(Electrical Assistant Secretary).

A number of sittings have been held by this committee to consider the advisability of issuing standards for electrical machinery, and to the direction in which the committee could render the greatest service to the British electrical industries. Finally, it was decided to form sub-committees for the purpose of dealing with various sections of the work. At the outset four of these subsidiary bodies were appointed to take up the subjects of: (1) Generators, Motors, and Transformers; (2) Temperatures; (3) Cables and Conduits; (4) Telegraphs and Telephones.

The immensity of the task to be accomplished soon made the fact evident that further assistance would be absolutely necessary, consequently six other sub-committees were appointed, bringing the total number up to ten. The following is a complete list, stating the subjects under consideration and the names of the respective Chairmen :

Generators, Motors and Transformers :
  Col. R. E. Crompton, C.B.
Transformers :
  C. P. Sparks, Esq.
Physical Standards :
  Dr. R. T. Glazebrook.
Electrical Nomenclature :
  Prof. Silvanus P. Thompson.
Telegraphs and Telephones :
  John Gavey, Esq.
Cables :
  Robert Kaye Gray, Esq.
Electric Tramways :
  A. P. Trotter, Esq.
Electric Railways :
  A. P. Trotter, Esq.
Central Station Rules :
  C. H. Wordingam, Esq.
Electric Automobiles :
  W. Worby Beaumont, Esq.
  Leslie S. Robertson, M.Inst.C.E.
  (Secretary).
  C. Le Maistre, A.M.I.E.E.
  (Electrical Assistant Secretary).

The first section of the important work assigned to sub-committee No. 1, on Generators, Motors and Transformers, was the standardisation of electrical pressures and frequencies. The sub-committee consists of the following gentlemen representing the Government departments, public associations, etc., appearing over their respective names :—

Col. R. E. Crompton, C.B. (Chairman).
War Office :
  Col. H. C. Holden, R.A.
  Captain A. H. Dumaresq, R.E.
Admiralty :
  Commander G. L. Sclater, R.N.
  L. J. Steele, Esq.
Crown Agent for Colonies :
  Llewellyn Preece, Esq.
National Physical Laboratory :
  Dr. R. T. Glazebrook.

Electrical Engineers' Plant Manufacturers' Association :—

B. H. Antill, Esq.
W. B. Esson, Esq.
A. C. Eborall, Esq.
S. Z. De Ferranti, Esq.
Robert Hammond, Esq.
Captain H. R. Sankey.
C. H. Wordingham, Esq.

Leslie S. Robertson, M.Inst.C.E.
(Secretary).
C. Le Maistre, A.M.Inst.E.E.
(Electrical Assistant Secretary).

The sub-committee soon decided that the best method of approaching this problem would be from the point of view of the users of lamps and of motors for power purposes, as these would be most affected by the decisions of the committee. It was therefore agreed that the standard pressures to be suggested should be measured at the consumers' terminals, as settled by Act of 1899.

As a number of different pressures, declared by various lighting and power authorities, are in existence at the present time, it was thought advisable to suggest the minimum number of standard pressures which would best meet present commercial requirements, and at the same time utilise to the fullest extent existing appliances belonging to consumers. It was finally decided that the direct current pressures of 110, 220, 440 and 500 volts would best meet the requirements, because apparatus designed for such pressures could be utilised for pressures 10 per cent. above or below the standard without alteration to the castings or mechanical parts, by simply altering the windings and excitation.

A circular, embodying the suggestions of the sub-committee, was submitted for consideration to the manufacturers and also to the leading consulting engineers and users of motors. By the replies received in response to this circular, it was made quite clear that all the leading consulting engineers and manufacturers were entirely in favour of the recommendations made. However, before coming to a final decision on the subject, the sub-committee arranged for a conference with the sub-committee on electrical tramways, with the result that an additional standard pressure of 600 volts was decided upon as the standard pressure for electrical traction.

In order to clear the way for the standardisation of prime movers for driving alternate current machinery, the effort was made to settle the question of standard frequencies at the earliest possible moment. The general concensus of opinion was in favour of frequencies of 25 and 50, but some members of the sub-committee thought it desirable to adopt a third frequency of 40 or 42, to permit rotary converters to be used to the fullest advantage. It was finally settled, however, after full discussion, that only two frequencies should be adopted, of 25 and 50 respectively.

After the recommendations had received the approval of the Electrical Plant Committee, the Publication Committee, the Main Committee, and the Board of Trade, it was deemed advisable, in the interests of the electrical industry of the country, to publish the findings on the questions of Direct Current Pressures and Frequencies at an early date, without waiting for the completion of the entire report.

The following is a copy of the resolutions passed by the committee, and we may add that copies can be obtained from the Secretary of the Engineers' Standard Committee, 28 Victoria Street, Westminster.

STANDARD DIRECT CURRENT PRESSURES AND STANDARD FREQUENCIES.

(1) That the Standard Direct Current Pressures, measured at the consumers' terminals, be :—

110, 220, 440, 500 volts.

(2) That the Standard Direct Current Pressures, measured at the terminals of the motors, be :—

For Tramways, 500 volts.
For Railways, 600 volts.

(3) That *25 periods per second* be the Standard Frequency for :—

- (*a*) Systems involving conversion to direct current by means of rotary converters.
- (*b*) Large power schemes over long distances.
- (*c*) Three-phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

(4) That *50 periods per second* be the Standard Frequency for :—

- (*a*) Mixed power and lighting on town supply mains.
- (*b*) Ordinary factory power plant.
- (*c*) All medium-size power plant where rotary converters are not employed.

* *

Motor-Driven Fire Pumps.

AN electrically driven fire protection plant recently installed in a large wholesale warehouse in Chicago by the Edison Company is worthy of attention. The equipment comprises a 100 h.p. G.E.C. 230 volt shunt wound waterproof motor driving through single reduction gearing a 8½ by 12 in. Laidlaw-Dunn-Gordon duplex pump. A fan is fitted for ventilating the armature windings, air being drawn in through the front of the motor casing and discharged at the opposite end, through pipes fixed for the purpose.

The supply cables are led in through a pipe screwed into the casing, and the motor is so constructed that a stream of water can be delivered upon it, or it can be completely submerged in water without injury. The pump runs at 60 r.p.m., and is connected with a sprinkler system extending throughout the building. Pressure of 100 lb. per sq. in. is constantly maintained by a pressure gauge designed so that when the water pressure falls below normal the hand of the gauge closes the circuit of an automatic controlling device, thereby starting the motor. When the pressure is restored the gauge hand closes another circuit through the controlling device, thus stopping the motor. The controller is also enclosed in a waterproof casing, and, even if the motor chamber should be completely filled with water, there would be no risk of the pump being thrown out of action.

Central Station Practice

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

* * *

INTRODUCTORY ADDRESS.

By the ASSOCIATE EDITOR.

* * *

It is but twenty years ago that the chapter on "Central Station Lighting," in the most advanced work of that date, consisted of four-and-a-half lines. Short as is a couple of decades in human history, a little span even in the life of many of our leading men of science, it has witnessed the inception, growth, and universal application of the subject about which the late Mr. J. E. H. Gordon could find nothing to say because there was nothing then to be said. The four-and-a-half lines of those days require to-day a bulky volume of five hundred pages to give even an adequate idea of the problems presented by that phase of the industry which *The Electrical Magazine* intends to cover as a whole, and of which this section is at once the synthesis and analysis, the former because in it is combined the various elements which, taken separately, occupy our attention in other sections, and the latter, in-so-much as it is only by the excellence of individual details that the final result can be made what it must be to achieve success, *i.e.*, economical.

As it is axiomatic that "quantity for quantity, it is more economical to produce energy on a large scale than on a small," the central station practician of to-day must perforce be a man of big ideas, yet with a grasp of *minutiæ* at times bewildering. ***Economy in the gross and economy almost to parsimony in the details is the only road to success.*** Whereas the dynamo designer is content if he has evolved a machine capable of efficiently acting as a transformer of energy, at a low capital cost, and the manufacturer of lamps and motors and accessories has finished his work, when reliable and successful apparatus leaves his hands, the central station manager has to discriminate between conflicting ideals, to be continually on the alert for means to enable him to compete with the ever improving and competitive means of artificial illumination and motive power, and to be ready, instant by instant, to meet the demands of his customers. In this section we intend to devote ourselves assiduously to showing how the problem thus presented has been attacked with success, and to point out the lines upon which developments may be expected and further progress made.

The close connection between the commercial and technical departments in central station practice cannot be impressed too strongly upon the younger members of the profession. In days when borough electrical engineers are to be found receiving salaries not much more than the wages paid in the more populous cities to skilled artizans, there is a tendency to depreciate business aptitude and to look upon technical ability as the principal factor and first recommendation of a candidate for a vacancy. That so few mistakes have been made and such excellent results attained by men who have emerged from pupilage but a year or two, is one of the most encouraging of all the facts in this department. We are now reaching the stage when total costs of a penny or less do not excite wonder, when energy is sold at under a halfpenny per unit, at a time when 80,000 volts pressure of transmission, 3,000 and 4,000 kilowatt generating sets, and mains with several square inches of copper are, if not commonly seen, at least frequently discussed and their use abroad described. England is now about to show examples of the most modern and the largest plants. No longer is it necessary to go to Germany or cite America in connection with the latest thing.

While in this section we do not propose to indulge in lengthy descriptions of prime movers and generating plant, there are a host of details to occupy attention. And it is rather to the operating than to the constructional side we would address ourselves. The central station supply business has been built upon the basis of Dr. Hopkinson's, Prof. Kennedy's, Mr. Hammond's, Mr. Crompton's and Mr. Arthur Wright's papers—and in these days of cheap supply, low costs and high load-factors we intend to be in the van. The hustler is the man for a power house—let the calm, calculating, precise physicist calculate our constants and tables for us, and give us ready to hand for immediate use, the results of devoted labour in the realms of pure science.

It is needless to say that in a section with such a heading as this, practical measurement will have an important place. The meter is the only means of determining the revenue, and it alone, of all the central station engineer's equipment bears the stamp of legal use. He may do what he pleases, within wide limits, with his plant, but his meters must be accurate. Plant can be duplicated, but mains stand by themselves to give or fail to give supply, and they are peculiarly the care of the central station man. Rates, tariffs, and methods of charging find their place also in this monthly record of progress, and it is our intention to cull from all sources practical hints on the up-keep and maintenance of the plant as well as the means of fulfilling the requirements of the consumer.

What is a Fireman?

FIREMEN are men first and stokers afterwards, whether they do their work west or east of the Atlantic. Here is the American opinion of the class:—"The average fireman has two objects in view: to keep a sufficient head of steam, and plenty of water in his gauge glass. The idea that he is burning money never enters his head. He does his work in the easiest way possible and the Company pays the bills." Recently one of our London Station Managers ventured something not much different. "The main object in life of the average human stoker when firing by hand appears to be to crowd on as much coal at a time as the furnace will hold—the bigger the lumps the better—then to shut the door and trust to luck."

"Artificial Loads" for High Tension Three-Phase Generators.

By J. P. KEMP, A.M.I.E.E.,

Late Resident Engineer, Stuart Street Station, Manchester.

TO central station engineers who take a keen interest in low works costs, the idea of dissipating energy in any form is doubtless repugnant.

In some new generating stations, however, some form of artificial load is a necessary evil, and must be provided for guarantee tests, and the correct adjustment of valves and governors. For this purpose the contractor supplying the electrical plant, generally secures an odd corner of the engine room or an outlying shed, and fits up a costly temporary arrangement, which is often unsafe when completed. This apparatus is roughly constructed, and frequently necessitates much adjustment before it can be used with any degree of certainty. Again, when an important test is being conducted, signs of failure in the tank sometimes become evident, and cause its abandonment after considerable cost has been entailed.

In continuous current stations with a good day load, tests and valve adjustments are often conveniently carried out on the town lighting load, and in the writer's experience, generating plant ranging from high speed sets of 180 K.W., at 2,000 volts, to slow speed sets of 1,800 K.W., 450 volts, have been satisfactorily tested in this manner, on full load for six consecutive hours.

This arrangement is ideal, but few engineers of large alternating current stations are able to "bank up" one of their large units, with unvarying full load, for six consecutive hours, as such stations are usually put down for supplying large areas with energy for power, traction and lighting, and during the hours of daylight the load fluctuations due to power and traction demand are very marked. It frequently happens that large power stations placed in the neighbourhood of growing industrial centres, are seldom called upon to supply loads exceeding a quarter of their plant capacity during the first six months of operation, and it is in this period, frequently the summer, that the majority of tests and adjustments are arranged for.

Where the load fluctuations are considerable, the adjustment of valve gear with engine on town's load is seldom satisfactory, as for this purpose the load should obviously be well under control and absolutely steady. If diagrams are taken when the engine is running in parallel with another set, a correct apportionment of load or steam pressure in the

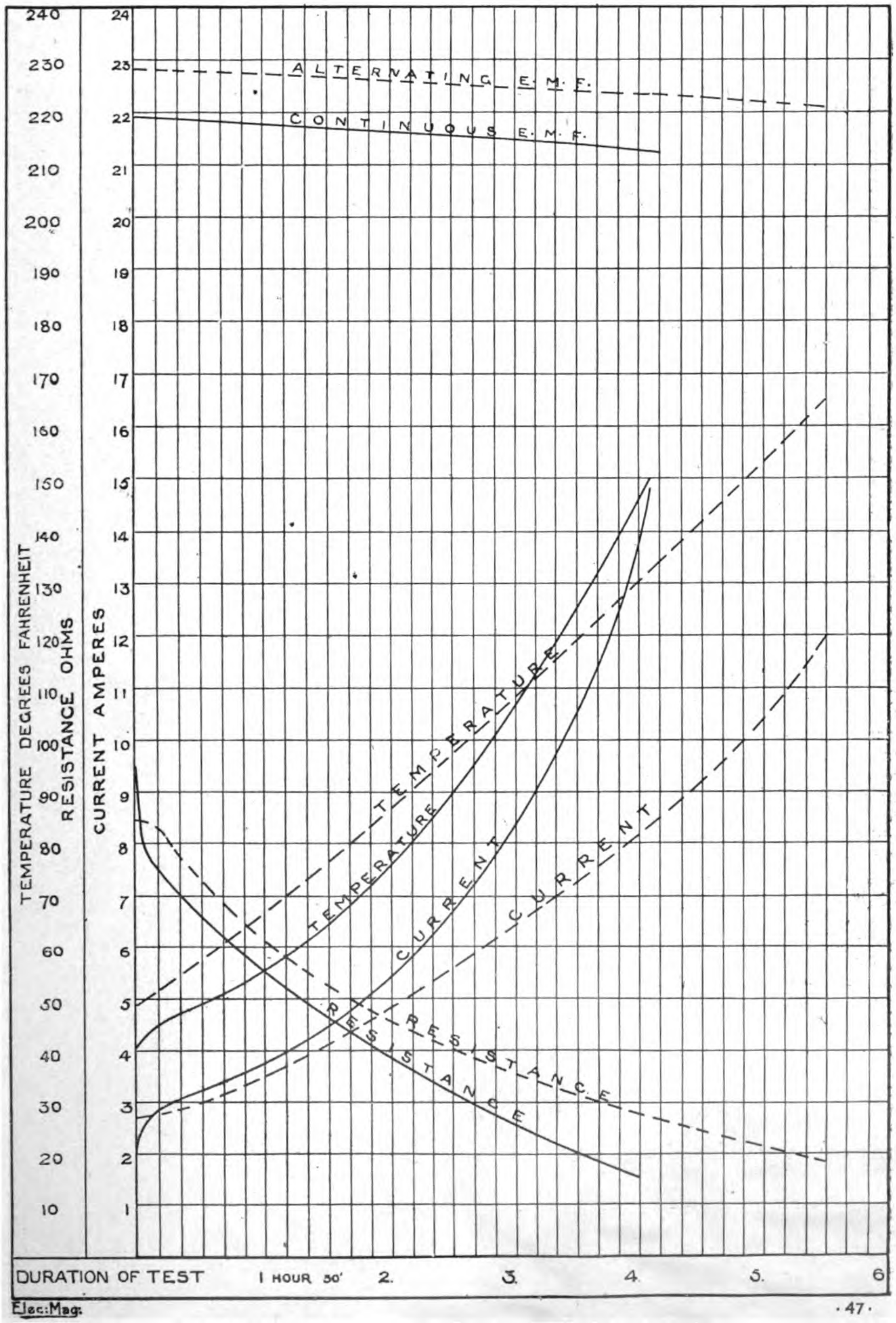

TEMPERATURE DEGREES FAHRENHEIT
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
RESISTANCE OHMS
CURRENT AMPERES
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
ALTERNATING E.M.F.
CONTINUOUS E.M.F.
TEMPERATURE
TEMPERATURE
CURRENT
CURRENT
RESISTANCE
RESISTANCE
DURATION OF TEST
1 HOUR 30'
2.
3.
4.
5.
6
Elec:Mag.
·47·

Fig. 1.

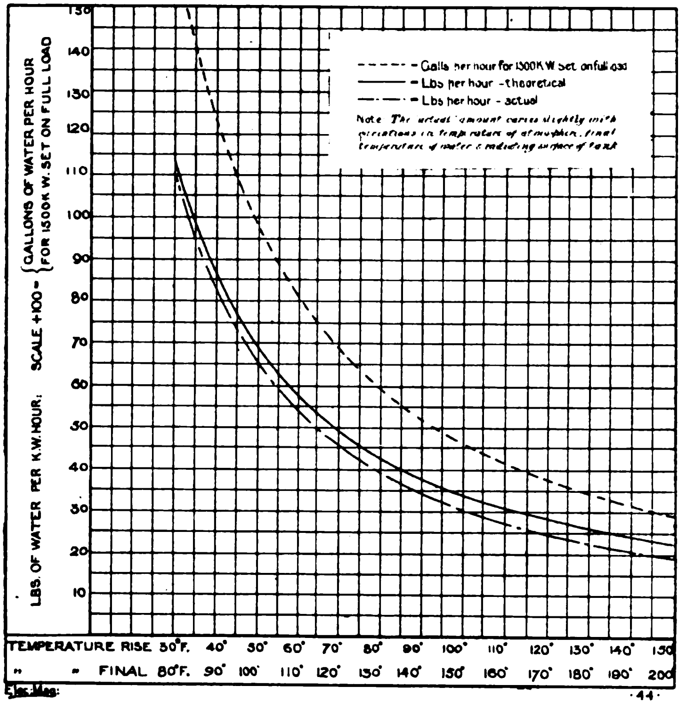


FIG. 1*a*.

cylinders is difficult to effect, as the variations in successive diagrams give most conflicting results. Satisfactory parallel running of alternators is mainly effected by uniform angular velocity, and with indifferent valve setting this may be far from uniform, thereby causing heavy cross currents between the machines, which for various reasons are most undesirable.

In the hands of a man, inexperienced in the potentialities and delicacy of electrical supply at high pressure, the adjustment of valve or governor gear with an engine on load might end in a shut down of the plant, or some other accident. These disasters would be very costly, and in the writer's opinion, this practice, although apparently so, is not always the most economical, and is not therefore commendable.

Where guarantee tests are carried out, the testing apparatus used should be reliable, non-inflammable, and capable of safe handling by the men in charge. The temporary wooden tank does not fulfil these conditions, as with moderately high pressures the saturated wood offers a ready path to the flow of current, followed by the phenomenon of fire under water, and resulting ultimately in an unexpected leak. In the writer's experience, men with more valour than prudence have, in their endeavours to cope with the difficulty, received exceedingly severe shocks, which under changed conditions might have proved fatal.

Dealing with large high tension three-phase power stations, the writer strongly favours a properly constructed test tank as part of the station equipment. Its value would be amply demonstrated during the first few months' use, while the enjoyment of an immunity from breakdowns and supply interruptions would more than compensate for its slight additional cost.

Having endeavoured to show that the adoption of such apparatus is well justified, some notes of the author's experience in the design of such a tank may be of interest.

The purity and consistency of the water used determines all the dimensions of the tank, therefore, canal or river water is not recommended, the cleanest water being generally obtainable from the town supply. The conductivity of the water is sometimes increased by salt or soda, but this mixture cannot be consistently maintained, and inconsistency causes very wide variations of load.

Town's water is also cheap, and after being used in the test tank, it can be passed on to the feed tanks as heated boiler feed, thereby effecting an appreciable saving in the amount of coal required.

Samples of water should be taken from the station supply mains, and tested for resistance at various temperatures—the results being perhaps most conveniently expressed as "the resistance in ohms between immersed electrodes

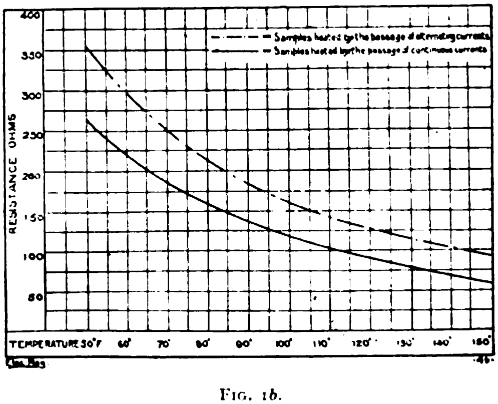


FIG. 1*b*.

one square foot in area and one foot apart." Obviously, this would not give the "Specific Resistance" per cubic foot of the sample of water under test, but the results obtained would be more suitable for calculations affecting the spacing of test tank electrodes, and could be applied in the same manner as the term "Specific Resistance" is applied in calculations affecting ordinary electrical conductors.

It will be found that the resistance decreases as the temperature increases, and within a range of a few degrees, the decrease in "R" is almost inversely proportionate to the increase in "T." This, however, is not long maintained, and from two experiments, carried out under identical conditions, with alternating and continuous currents, on samples of water as received in Manchester, the author has prepared Fig. 1, which shows the relative changes that occur in resistance, current, and temperature.

The experiments were maintained for 5½ and 4 hours respectively.

The rapid decrease in resistance following decomposition of the water by continuous current is particularly marked.

Fig. 1*b* gives the resistance of the above water at various temperatures, per square foot of immersed electrode placed one foot apart. If vapour is to be avoided, the final temperature of the water should not exceed 120° F, at the outlet. If the supply enters at 50°, this would mean a temperature rise of 70°, and would require theoretically about 49 lbs. of water per K.W. hour, but owing to surface radiation, about 85 to 95% of this amount will generally be found sufficient in practice.

Fig. 1*a* is of interest in giving the approximate amount of water required per K.W. hour for various temperature rises, and the number of gallons per hour needed by a 1,500 K.W. set at full load.

This diagram indicates that the total amount of water required per hour with a temperature rise of 110° is about equal to the amount required by boilers to supply steam to a 1,500 K.W. set running condensing, but as this would mean a final temperature of 160°, trouble might be experienced with the vapour, which if sufficiently dense, would cause the electrodes to flash over. Lower temperatures are therefore advisable; the supply of water and position of electrodes can be arranged accordingly, the surplus water being still used as boiler feed for other station plant.

The following descriptions and illustrations of a tank for dealing with three phase currents at loads varying from zero to 2,000 K.W. at 7,000 volts will prove interesting in the light of the foregoing remarks.

The tank is of galvanised iron plate $\frac{5}{32}$ in. thick, strengthened with, and rivetted to angle iron rings. It is cylindrical and 6ft. diam. and 4ft. 3in. deep. It is placed over the main feed tanks (under cover) and in series with one of the main water pipes, the supply of water being regulated by a large ball valve,

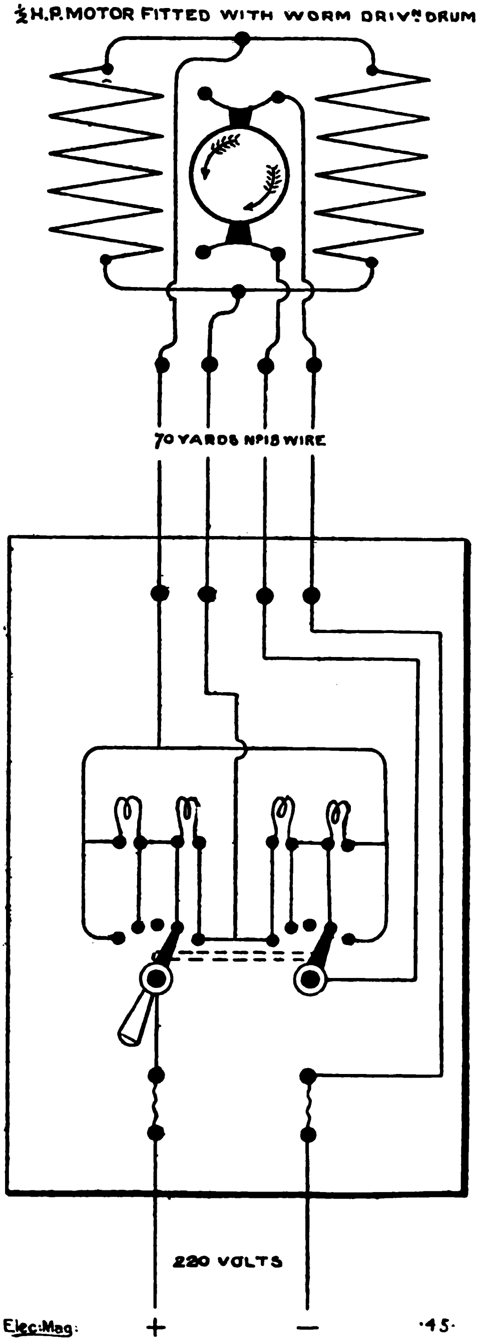


FIG. 2. DIAGRAM OF MOTOR CONNECTIONS.

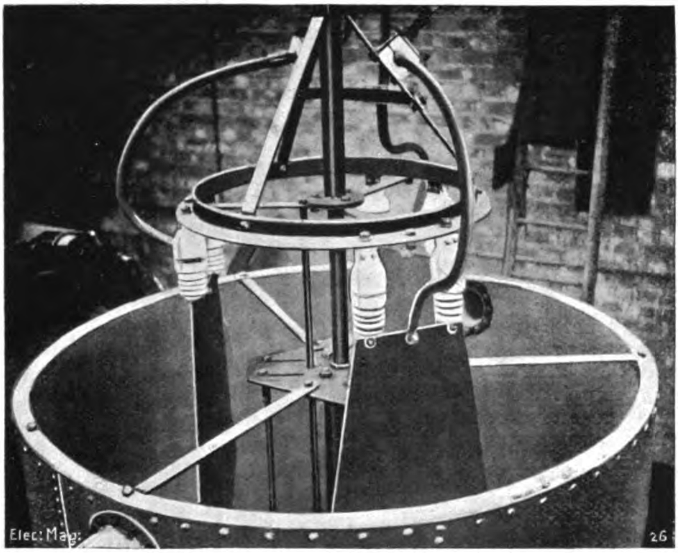


FIG. 3. TANK WITH ELECTRODES RAISED.

in the feed tank. A 4in. iron pipe enters the centre of the tank, and to the bottom of this the supply pipe is connected. A number of holes of $\frac{3}{8}$in. diam. and aggregately of greater area than the supply pipe, are bored near the bottom of the centre pipe, and through these the cold water is introduced at the bottom without disturbing the water at the surface. Immediately below water level a few holes are also bored, which allow a small portion of the cold water to mix with the heated surface water and prevent the formation of vapour.

The top of the 4 in. centre pipe is blanked off by a triangular plate to which neutral electrodes are fitted (with room for adjustment), and as the framework of the tank is substantially earthed, the generator on test will be run with an earthed neutral point. This matter is important in the event of having to change over from the tank to the town supply, the neutral of which is not earthed; but with an equal degree of insulation on all outers this operation is not attended with any particular risk.

At the top of the triangular neutral plate, a small vertical pipe is fixed, and this acts as a guide for the outer electrode frame, the latter being free to travel vertically within certain limits indicated by a bell on the switchboard.

As the test tank is erected over the feed tanks in the boiler house, about 70 yards from the switchboard gallery, it was found necessary to provide a reliable method of controlling the load on the generator from the switchboard by raising or lowering the electrodes in the test tank. A small shunt wound enclosed motor to effect this was erected near the tank and fitted with a worm driven drum, blocks and tackle.

The station lighting supply being at 220 volts, a starting resistance in series with the motor armature would have been necessary, and as this meant separate excitation for the motor, and additional complications, a simpler plan was devised, dispensing with the starting resistance, and also the blowing of fuses in the event of the motor being pulled up. By this method an adjustment of the electrodes within $\frac{1}{16}$ of an inch could be made, and reversal from a distance was also possible.

Fig. 2 shows the arrangement. Obviously

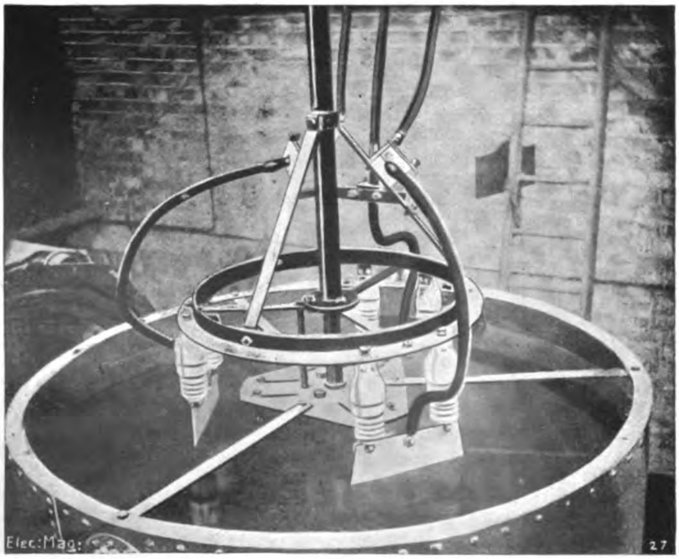


FIG. 4. TANK WITH ELECTRODES LOWERED.

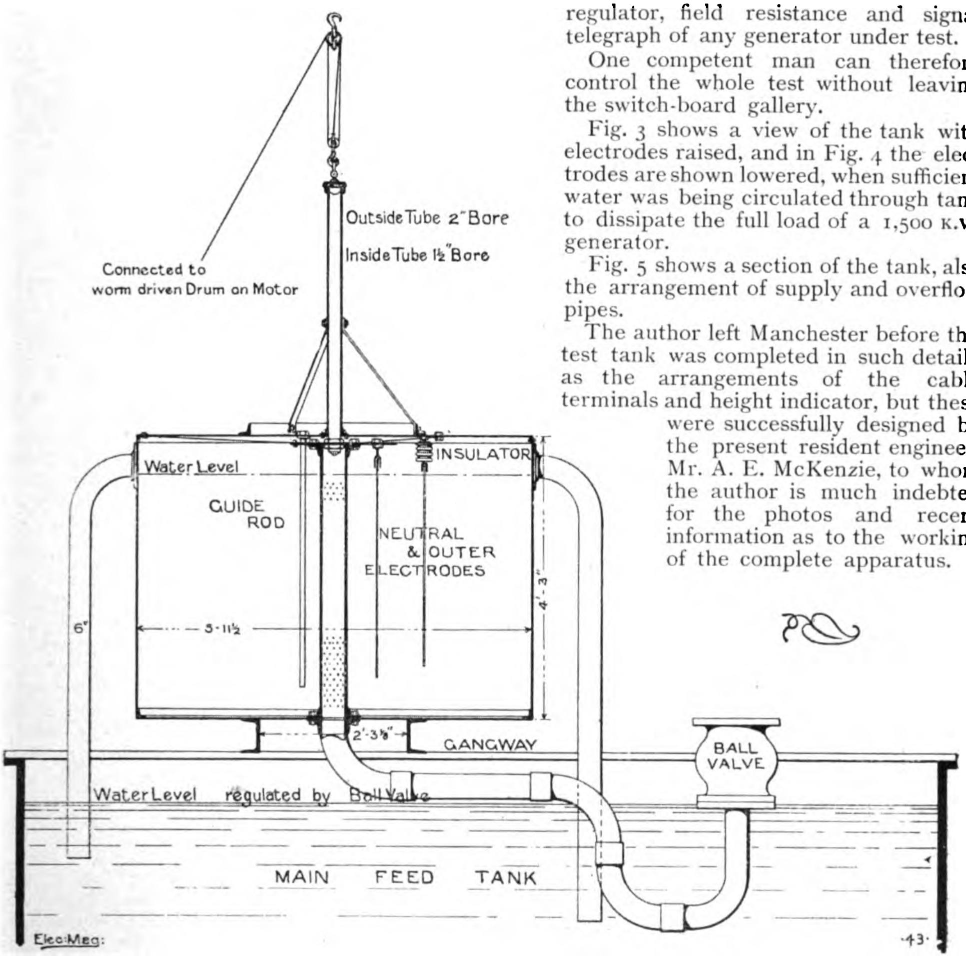


Fig. 5. Section Through Tank.

it is not one whereby the maximum torque could be obtained from a shunt wound motor, but as the maximum power required was only 400 watts, it proved to be the most satisfactory under the circumstances.

Reference to the diagram of connections on Fig. 2 shows the two shunt field spools coupled in parallel and placed in series with the armature by means of a switch.

The high voltage lamps across the switch contacts were provided as a path for the self-induced currents from the field coils when changing over, and successfully prevented damage to the insulation, and sparking at the contacts.

Four wires (No. 18) are run to a small portable switch panel, fixed to a portable iron bracket, which can be fitted in any position on the switchboard gallery rail and in close proximity to the main switch, governor regulator, field resistance and signal telegraph of any generator under test.

One competent man can therefore control the whole test without leaving the switch-board gallery.

Fig. 3 shows a view of the tank with electrodes raised, and in Fig. 4 the electrodes are shown lowered, when sufficient water was being circulated through tank to dissipate the full load of a 1,500 K.W. generator.

Fig. 5 shows a section of the tank, also the arrangement of supply and overflow pipes.

The author left Manchester before the test tank was completed in such details as the arrangements of the cable terminals and height indicator, but these were successfully designed by the present resident engineer, Mr. A. E. McKenzie, to whom the author is much indebted for the photos and recent information as to the working of the complete apparatus.

* * *

CENTRAL STATION NOTES.

Calculation of Costs.

A short time ago we remember reading a paper on estimating the cost of foundry work, and the remarks seemed so *apropos* of central station costs that they are worth paraphrasing. Slightly altering the subject, they apply with force to electricity supply methods. To make a correct estimate of the actual cost of units sold is, perhaps, one of the most difficult of the duties which devolve upon the engineer in charge of generating plant. There are so many little insinuating expenses which can only be determined with the utmost difficulty, and which vary so constantly that many engineers give up the task as a hopeless one, make a rough guess, and establish an error at the very basis of all their calculations. It is an easy matter to open an account with the works and after six months or a year to foot up the expenses for coal, oil, wages, and all the thousand and one incidentals which will come up, and divide the total by the output in units sold, and say that the latter have cost a half-penny or a penny each, as the case may be. But this is of very little account. Suppose that we attempt to sell all units at a constant price and make a fair profit above the average cost. The inevitable result will be that we are overcharging one class of customers and losing money with others. One class of business may be worth twice or even ten times as much per unit as its neighbour, and yet no system of general averaging will point it out. The only way, then, is to make a detailed estimate of the sales at each load factor, and ascertain what has been the cost of the sales at each individual percentage. When shall we see this done, not in one or two of our larger works, but generally practised throughout the profession?

Naked Leads for Heavy Currents.

For distribution at 220 volts, naked leads in porcelain or earthenware insulators are generally considered satisfactory if the trough or trench containing them can be kept dry and free from dirt. But the safety of the arrangement may be impaired by a "short circuit" on the system, other than the bare conductor portion.

At a power station in the Midlands, current is distributed right and left from a central switchboard by ⅞ in naked copper rods, laid 3 in. apart, in china insulators in cement trench covered with short boards and further protected by cast iron floor plates. Nine pairs of leads, each carrying 500 lamps, 220 volts, were run in each direction, and each pair ended in a right angle connection passing through the power house walls, and those to the outside circuit. For six years this gave no trouble, and the existence of the leads was almost forgotten. All these separate circuits were in parallel with the bus bars, the separate circuits being fused on the main switchboard, but were not afterwards protected. A short time ago, a short circuit occurred some distance from the naked conductors, and before the fuse acted, the rush of current in the naked conductor in the trench had caused it to expand to such an extent that it broke the jaws of the insulator, and writhed up over the other conductors, causing them in their turn to elongate and burst their insulators. The fuses by this time had operated, and, although, the atmosphere was charged with burning fuse metal, little damage was done, as the engines were well under the control of the governors.

A subsequent examination of the trench showed it to be full of twisted and distorted conductors, the elongation being in some cases quite 2½% of the total length, and this seemed to be accompanied by a permanent dilation, as it was impossible to detect any reduction of diameter.

This was, of course, an unusual and in many respects an unique accident, but it goes to show that where naked leads are laid in close proximity to each other it is desirable to use sensitive fuses and automatic cut outs; or to confine the conductors in such a way that if they move they do no harm.

The Use of the Economiser.

At a recent discussion on the Economiser, by the New York Railroad Club, Mr. R. D. Tomlinson, Chief Engineer of the Inter-Borough, submitted some tests of the economiser plant at the Manhattan power-house. He showed a net return of 30.5% on the initial outlay, and presented the interesting fact that the reduction of draught in passing through the economiser was only 0·16 of an inch of water with the connected boilers running about 6% above the makers' rating, and 0·23 of an inch at 13%. Each test indicated that the water had been heated about 40 degrees per 100 degrees reduction of the gas temperature. Some writers assumed 20lb of flue gas per lb of coal, 3·7lb of coal per H.P. hour, and 30lb of water per H.P. hour, there would be approximately 2·5lb of gas per lb of water, which, if its specific heat be taken at 0·23, would liberate 57·5 heat units and heat the water that much in cooling 100 degrees. Mr. Blackburn, of the Green Fuel Economiser Co., submitted three arrangements, where the estimated saving would vary with the load and arrangement, from minus ·21% to plus 8·6% of the total investment, with fixed charges of 19% on apparatus and 13% on buildings, or from 4·77 to 32·9% with fixed charges of 14 and 8%, respectively, the first and last fixed charges including 5% interest on the investment. As the fixed charges form a considerable portion of the gross saving, a reduction in this item makes a marked increase in the percentage of net saving. Mr. E. B. Katte, of the New York Central Staff, presented figures showing a saving with the economiser of $200 per year on an investment of $85,500, or just over two-tenths of 1%.

A Portable Sub-Station.

Mr. S. E. Fedden, Manager of the Sheffield Corporation Electric Supply Department, has supplied us with some interesting particulars of a portable sub-station design made by him and put into service on his distributing system. The "Sub-Station" consists of a substantial pantechnicon, fitted with massive wheels, and containing two 50 K.W. Burnand transformers, specially designed for close regulation on inductive loads. The equipment provides for the supply of single or two-phase current at 400 or 200 volts. Oil or dust fuses can be inserted on the H.T. side of the transformer, the L.T. sides being connected to bus bars, from which four-cored distributors branch off through removable links. These cables enter from the pipes or trench underneath the van. Two high pressure feeders can be run into the sub-station. The van is provided with ventilators for securing a good circulation of air, and the end door, giving access to the switchgear, is hinged at the bottom, thus forming an insulated platform for the operator. The whole can be drawn by horses to any convenient spot from which it is desired to give a temporary load, such as for an exhibition or the supply of consumers during the construction of a sub-station.

⁂

Hints on the running of central stations, maintenance of mains, meters, etc., will be welcomed for insertion in this section of The ELECTRICAL MAGAZINE.

ELECTRICAL · WORK and · PRACTICE in · the · Shops

The Artisan's Section.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike, which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

FOREWORD.

By W. E. WARRILOW (Act. Ed.).

THE preceding sections of *The Electrical Magazine* will be found of interest to electrical men generally, seeing that information in a concise form on the chief branches of the industry is assembled therein. The foreman or artisan will doubtless scan those pages to pick out items of specific interest to himself, but in no one of them will he find his own particular sphere of labour specially treated. As the inscription above explains, this section of the magazine has been exclusively reserved for matters, of little value perhaps to the electrical engineer in the broadest sense of the name, but of exceptional worth to the practical worker who is continually "up against" difficulties only to be encountered in the making of electrical apparatus.

The field to be covered is a wide one, extending over that broad expanse of industrial activity bounded on the one side by such monster constructions as dynamos of great output, and on the other by delicate mechanisms which impress the imagination as much by their minute details as do the massive proportions of the generators at the other end of the scale. Interspersed between these extremes, the accessories, which are indispensable in making up the sum total of electrical appliances, will receive a due share of attention, in treating of their manufacture.

In addition to considering the manufacture of this host, from the casting of the raw material to the finished product in the shops, the actual removal and erection of the machinery and accessories will be included in the bounds encompassed by this section, for we feel that production in the workshops represents but a portion of the development of any particular article of manufacture.

The chief object of the section, then, is to deal, within the limits specified, with those knotty problems which are continually presented to practical workers, and which are always solved by that knowledge which ranks not in text books nor is to be found in the canons of workshop law. Anomalous as it may seem, in spite of the pitch of perfection to which machine tools have been brought and erection methods developed, the production of some engineering giant has oft-times only been accomplished by recourse to measures outside the recognised routine. This is only as it should be, and engineers are to be complimented upon their resourcefulness in thus supplementing the comparative deficiencies of devices which—valuable enough in meeting the mechanical exigencies of the case—cannot provide what are really the mental touches necessary to the completion of the work. Every trade abounds with wrinkles, and every workman carries a greater or less supply ready to hand for his purpose as occasion demands.

It is with these that we purpose to deal in this section of the magazine, and a hearty invitation is herewith extended to all workers, in whatsoever portion of the electrical industry, for contributions relating to the scope of the section, in accordance with the outlines given.

As the head note indicates, prizes will be presented for the most valuable hints, and every encouragement will be given to our artisan readers to make the section an indispensable medium of reference for reliable information on workshop practice and erection methods.

Electrical work in the shops is of so varied a character that it is difficult to set limits on the scope of this section ; consequently, it will be found that we shall touch upon matters not always electrical, but so closely allied that the information imparted will be of value to any worker in an electrical manufacturer's machine shop. The tendency to produce as much as possible at the spot where assembly of the various parts will take place, has resulted in our great electrical factories developing their own pattern shops, foundries, and many smaller departments equally important in furthering the progress of raw material towards its final completion in the machine shop ; consequently, other workers are becoming merged into the body of electrical artisans, and kindred interests are arising which would otherwise have remained dormant. It will be our endeavour to cater for these practical men, be they engaged on the moulding of a field frame, or the assembly of delicate instruments, and in extending the invitation mentioned above we expect a hearty response from electrical workers as a whole.

We are also open to receive suggestions as to the manner in which the section might best become a medium of reference to those for whom it is intended. It will be our policy to build up the section in accordance with our readers' views, and when it finally crystallizes into definite shape we venture to think that it will be one of the strongest links in the chain, which, with the other sections, it will help to form. We naturally expect a wide divergence in the suggestions made, but we anticipate a middle course along which to run the section, and yet make it equally conformable to the generality of our readers.

❧

Useful Belt Hints.

Although direct motor-driving is coming to the front, the services of the belt man in electrical workshops are still indispensable. The following useful facts, taken from a recent issue of *Power*, will doubtless be found of value to this apparently insignificant, but nevertheless highly important, member of the machine shop.

The horse power transmitted by a good belt can be found by multiplying the width of the belt by its speed in feet per minute, and dividing by a constant ranging from 1,000 for a single belt to 400 for a heavy cemented belt. The operation, including calculation of the belt speed, is expressed by—

$$\frac{\text{Diam.} \times 3.1416 \times \text{revs.} \times \text{width}}{\text{constant}} = \text{H. P.}$$

This, with constants varying from 1,000 to 400, would amount to diameter multiplied by revs., multiplied by width, multiplied by ·0031416 for the weakest belt, to ·007854 for the heaviest. These values are assumed, consequently we may call them ·003 and ·008, and deduce the following :

TO FIND HORSE POWER WHICH GIVEN BELT WILL TRANSMIT.

Rule : Multiply diameter of either pulley in feet by revs. per minute, and width of belt in inches. Multiply above product by a value ranging from 3 for light, single-laced belts, to 8 for double, heavy, cemented belts, and point off three places from the final product.

Example : What power can be transmitted by a 6-inch double belt running on a 4-foot pulley at 200 revs. ?

Diam., multiplied by revs. and width together, gives :

$$4 \times 200 \times 6 = 4{,}800.$$

Assuming belt of such width and quality and joint made, so that 6 can be chosen as constant,

$$4{,}800 \times 6 = 28{,}800 = 28{\cdot}8 \text{ H.P.}$$

TO FIND WIDTH OF BELT TO TRANSMIT A GIVEN H.P.

Rule : Multiply H.P. by 1,000, and divide by the product of the pulley diameter, revs. per minute, and chosen constant.

Example : What width of belt would be required to transmit 28·8 H.P. with a 4-foot pulley at 200 revs. ?

$$\frac{28{\cdot}8 \times 1{,}000}{4 \times 200 \times 6} = 6 \text{ inches.}$$

The chief difficulty with these rules is an intelligent selection of the constant. It should be chosen to give, not maximum horse power a belt will transmit, or the narrowest belt which will possibly transmit the power, but the amount it will comfortably carry without shortening its life or that of the man who has to take care of it. Experience only can act as a guide. If a belt is known to work nicely under a load about as much as it should carry, the constant for that belt can be found and used for finding the capacity of similar belts of other widths and at other speeds. The constant may be found as follows :

$$\frac{\text{H.P.} \times 1{,}000}{\text{Diam.} \times \text{revs.} \times \text{width}} = \text{constant.}$$

By experimenting with this upon belts the safe capacity of which is known, a line of constants can be obtained which will form a quick and accurate guide to the capacity of any familiar belt or to the width of the belt required for a given job. When there is a considerable difference in the diameters of the pulleys and the shaft centres are close together, allowance must be made for the small arc of contact on the smaller pulley, but sufficient experience will indicate this in choosing a constant.

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrcial trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

THE FISCAL PROBLEM.

By the ASSOCIATE EDITOR.

During modern times no question of more momentous character has ever been raised for the consideration of the British Nation than that now propounded by Mr. Chamberlain. Even the agitation commenced by Mr. Cobden, which terminated in acceptance of the Free Trade policy, involved consequences of less importance than those depending upon the ultimate decision of the nation with regard to the proposal that our existing fiscal policy should be reversed. We say the consequences were of less importance, for the sufficient reason that British trade, and especially British industries in the present day, are more intimately connected with the prosperity of the community at large than they were in bygone generations. In former days the question recurring year by year was whether the harvest would be good or bad. If good, then the nation rejoiced and felt that prosperity was assured for at least one brief spell. If bad, then a period of general depression was anticipated and generally encountered. This state of things has changed. We still have good and bad harvests—more frequently bad than good—but in mercantile and industrial circles comparatively little attention is paid to purely agricultural matters, and increasing attention is devoted to the conditions of trade with other countries of the world. The closing of "open doors," the out-pouring of surplus productions from countries which have doors only opening outwards, are things that excite far more uneasiness than the vagaries of the English climate.

Among the industrial classes of this country the proposed reversal of the fiscal policy that has prevailed for more than half a century has met with a varied reception. There are some who will not allow themselves to think about a suggestion that seems to savour of heresy to a doctrine which is held to be almost as sacred and cherished a safeguard as Magna Charta itself. On the other hand there are some who have long held the view that protection is the natural privilege of all manufacturers, although not of farmers and others who suffer equally from foreign competition. And, between these two extreme parties, we have some who advocate, or at any rate who are prepared to welcome, some diluted form of protection or mitigated type of free trade.

But, in addition to these three classes, we have one other, comprising people who are not yet prepared to make a definite decision as to the policy most suitable for this country.

There is a good deal to be said in favour of the last mentioned class, for the attitude is one implying the careful weighing of consequences before taking a step—not necessarily irrevocable, but at any rate irrevocable for a considerable period of time. We have every sympathy with those who believe in looking before they leap, and then in taking care not to leap before they are fully prepared. As a matter of fact, it was from a somewhat similar policy of prudent foresight that the publication of *The Electrical Magazine* was deferred until the present date, so that every one of the multitudinous details necessarily involved in the complex organisation of the commercial and technical staff had been finally and completely settled. Our readers will therefore realise our entire approval of a mental attitude implying full deliberation of the changes now suggested.

With politics, using the term in the accepted sense of party politics, we have nothing to do.

We are concerned solely with the true interests of electrical engineering and of general engineering in such branches as are allied with electrical practice. Pure electrical science, happily, is quite beyond the influence of mundane governments, but applied electricity, as represented by electrical industries, may be seriously affected for good or for bad by legislative enactments in this and in other countries of the world.

Our special purpose in establishing a Trade and Commerce Section in this magazine is to communicate to our readers items of information, gathered by our Intelligence Department and otherwise coming to our notice, with the object of promoting and assisting British electrical trade. We are already in possession of valuable data, received from our special correspondents, and obtained from various official sources, which throw useful light on the subject now under discussion. The facts before us point most unmistakably to the existence of hostile influences against which British manufacturers cannot hope to contend. Foreign countries are encompassed with high tariff walls, the gates of which are closed to us except on payment of prohibitive tolls. Our own land is the only one among manufacturing countries that is not hedged around by protection. Other nations, living secure behind the shelter of their massive ramparts, sally forth from their gates and, crossing our unfortified frontiers, invade and over-run our territories. The invasion, we admit, is a peaceful one, and is welcomed by some classes of the community not directly concerned in manufacture, as well as by some members of the manufacturing interest.

The all-absorbing question at the present moment is whether peaceful invasion on the one hand, and the prohibition of similar action by ourselves on the other, is a desirable condition of things. During the last few weeks both sides of the case have been stated with much ability by men of great experience and mature judgment. Writers in leading technical journals and the daily press have stated their views with much freedom, sometimes using almost identical figures for the purpose of arriving at widely diverging results. So far as the general aspect of the question is concerned, there can be no doubt that universal Free Trade would be an immense convenience to the world at large, it would sweep away the artificial barriers that cramp and confine the energies of some nations and give extended scope for the energies of other nations. With free markets in every country of the globe we should certainly have ideal conditions for the pursuit of trade and commerce. Such an ideal, which was the dream of Cobden and his colleagues, is not likely to be realised, for the universal tendency even among the younger nations of the British Empire is to regard protective legislation as a necessary and indispensable part of the economic system.

It seems, then, that if we continue to pin our faith to Free Trade we shall stand alone in its practice. The question suggested by this consideration is whether we can permanently maintain our prosperity while occupying so isolated and so vulnerable a position. In dealing with this point we will first inquire into the history of our export trade in electrical appliances, as written in the statistics contained in the recently published Blue Book relating to British and Foreign Trade.

TABLE I.

Exports of Electric Lighting Apparatus and Telegraph Wires and Apparatus, manufactured or partly manufactured in the United Kingdom.

TO ALL DESTINATIONS.

Year.	Electric Lighting Apparatus.	Telegraph Wires and Apparatus.
	£	£
1890	281,000	1,602,000
1891	239,000	1,434,000
1892	175,000	910,000
1893	215,000	1,063,000
1894	246,000	1,386,000
1895	336,000	782,000
1896	382,000	857,000
1897	449,000	998,000
1898	515,000	985,000
1899	511,000	1,407,000
1900	546,000	2,801,000
1901	553,000	3,148,000
1902	618,000	2,839,000

The figures in Table I. are satisfactory as far as they go. There has been a marked and fairly steady advance in the export of electric lighting apparatus, and the increase has been far more pronounced than the growth of population from 37·5 millions in 1890 to 41·9 millions in 1902. There has also been a fair increase in the export of telegraph wires and apparatus, but the returns indicate great irregularity, and give rise to a feeling of uneasiness as to the continued prosperity of this branch of trade.

Analysis is necessary if we wish to grasp the true meaning of the figures. We have therefore shown in Table II. the distribution of the same exports between Foreign Countries and British Possessions.

TABLE II.

Exports of Electric Lighting Apparatus and Telegraph Wires and Apparatus, manufactured or partly manufactured in the United Kingdom.

Year.	To all Foreign Countries.		To all British Possessions.	
	Electric Lighting Apparatus.	Telegraph Wires and Apparatus.	Electric Lighting Apparatus.	Telegraph Wires and Apparatus.
	£	£	£	£
1890	187,000	720,000	94,000	882,000
1891	134,000	604,000	105,000	830,000
1892	87,000	731,000	88,000	179,000
1893	102,000	608,000	113,000	455,000
1894	126,000	208,000	120,000	1,178,000
1895	179,000	536,000	157,000	246,000
1896	174,000	540,000	208,000	317,000
1897	238,000	385,000	211,000	613,000
1898	267,000	299,000	248,000	686,000
1899	242,000	557,000	269,000	850,000
1900	222,000	2,282,000	324,000	519,000
1901	180,000	1,069,000	373,000	2,079,000
1902	195,000	1,029,000	423,000	1,810,000

In the foregoing table we again notice the striking fluctuations exhibited by exports of telegraph wires and apparatus. The high figures attained in 1894, 1900, 1901 and 1902, were due to large exportations of telegraph materials to the Azores, the United States and Brazil, among foreign countries, and to Canada, Mauritius, Ascension and Aden among British Possessions. The statistics show the capacity of British manufacturers to deal in a successful manner with emergencies, but it is by no means certain that the favourable returns of the last two or three years will be maintained. Taking general averages for the period 1900-1902 we find that British Possessions are better customers than all the rest of the world.

Turning attention next to electric lighting apparatus we are confronted first with a marked stagnation in the exports to foreign countries. Taking averages in periods of three years from 1890 to 1901 we get the following approximate results:—

1890-1892	...	£136,000	average
1893-1895	...	£136,000	do.
1896-1898	...	£226,000	do.
1899-1901	...	£214,000	do.

Here we find two periods wherein no advance is exhibited, and two others showing a satisfactory increase. But the figures in Table II. for 1901 and 1902 evidence a serious decline, and as a matter of fact the exports to foreign countries in those years were less than in the year 1890. Considering the growth of population and the great development of electrical industries in this country during the period 1890-1902, it is abundantly evident that foreigners are not taking a fair share of our products.

Very different has been the progress of the export trade with British possessions. Instead of stagnation we have vigorous life. The exports of electric lighting apparatus have risen from £94,000 in 1890 to £423,000 in 1902, and the increase has been steadily progressive practically year by year.

Let us dissect the figures still further, inquiring first into the values of the exports to the leading foreign countries where prohibitory duties stand in the way of British trade. The basis of the subjoined Table is again the Blue Book of 1903.

TABLE III.

Exports of Electric Lighting Apparatus and Telegraph Wires and Apparatus manufactured or partly manufactured in the United Kingdom, to the undermentioned Foreign Countries.

E. L.—Electric Lighting Apparatus. *T. W.—Telegraph Wires and Apparatus.*

Year.	Germany.		France.		Belgium.		Russia.		United States.	
	E.L.	T.W.	E.L.	T.W.	E.L.	T.W.	E.L.	T.W.	E.L.	T.W.
	£	£	£	£	£	£	£	£	£	£
1890	—	72,709	—	1,439	3,775	—	11,264	5,011	—	25,626
1891	—	196,026	—	15,844	2,939	—	5,315	15,916	—	3,661
1892	—	39,092	—	5,199	2,862	—	3,647	29,032	—	14,992
1893	—	6,873	—	8,075	16,939	—	8,519	13,849	—	5,192
1894	—	6,558	—	5,781	14,492	—	20,117	7,380	—	4,576
1895	—	21,638	—	10,234	17,234	—	20,672	7,278	—	1,753
1896	—	115,580	—	37,152	23,123	—	13,186	10,995	—	1,147
1897	—	14,250	—	1,599	22,360	—	23,844	9,825	—	4,535
1898	—	40,773	—	1,759	19,174	—	68,237	8,393	—	15,585
1899	—	11,651	—	3,961	27,957	—	58,494	13,751	—	50,057
1900	—	57,854	—	1,799	33,843	—	11,131	8,486	—	519,175
1901	—	13,044	—	954	19,951	—	6,141	8,528	—	35,048
1902	—	12,318	—	—	6,050	—	6,265	11,645	—	388,222

This table shows that the chief manufacturing countries require very little from us in the way of electrical appliances beyond telegraphic wires and apparatus. Holland and Italy, it may be remarked, buy absolutely nothing coming under the headings provided for electrical manufactures in the Blue Book, and of the five countries mentioned in Table III. only two appear to be purchasers of electric lighting apparatus.

With the exception of recent abnormal demands from the United States for telegraph wires there is nothing of a reassuring character in the statistics furnished in this table.

Once more let us turn to British possessions and see what is the state of our export trade with such countries. In Table IV. we have the exports of Electric Lighting Apparatus and Telegraph Wires and Apparatus, analysed under three typical headings, and in every case we find a thoroughly satisfactory growth in the demand for the former class of products.

TABLE IV.

Exports of Electric Lighting Apparatus and Telegraph Wires and Apparatus manufactured or partly manufactured in the United Kingdom.

E. L.—Electric Lighting Apparatus. T. W.—Telegraph Wires and Apparatus.

Year.	British India.		Self-Governing Colonies.		Other Colonies and Possessions.	
	E.L.	T.W.	E.L.	T.W.	E.L.	T.W.
	£	£	£	£	£	£
1890	13,000	13,000	56,000	390,000	25,000	479,000
1891	25,000	71,000	72,000	142,000	8,000	617,000
1892	9,000	8,000	72,000	137,000	7,000	34,000
1893	13,000	4,000	93,000	115,000	7,000	336,000
1894	23,000	5,000	88,000	901,000	9,000	272,000
1895	27,000	4,000	121,000	153,000	9,000	89,000
1896	30,000	5,000	168,000	226,000	10,000	86,000
1897	36,000	6,000	148,000	283,000	27,000	324,000
1898	42,000	13,000	184,000	228,000	22,000	445,000
1899	45,000	10,000	188,000	591,000	36,000	249,000
1900	60,000	15,000	228,000	385,000	36,000	119,000
1901	85,000	23,000	260,000	586,000	28,000	1,470,000
1902	106,000	36,000	287,000	1,633,000	30,000	141,000

The records from which all the foregoing figures are abstracted are not arranged so as to permit of a direct comparison between the exports to free and protected markets, but inasmuch as the only British colonies which may be properly regarded as "protected" are Canada and Victoria, over the period throughout which the statistics extend, it is possible to draw a fairly accurate general conclusion as to the practical influence of hostile tariffs upon British electrical industries.

The memorandum prefatory to the statistics presented in the Blue-book states that "there can be no doubt as to the effect of Continental and American tariffs in checking our export trade, especially in manufactured articles within the last two decades." A similar conclusion is to be drawn even from the figures we have already presented. Unfortunately, we are unable to give complete data relative to exports of electrical and allied machinery and plant owing to the imperfect system of classification adopted by the Board of Trade. It would be easy to tabulate returns as to the export of goods coming under the heads of Instruments and Apparatus, Machinery, Steam Engines, Metals and manufactures thereof, but these would not refer exclusively to electrical manufactures. We think it better, therefore, to present a summary showing the exports of all manufactured articles to each of the main groups of protected and free markets, during the period 1850—1902.

From the table on page 99 it is quite clear that there has been a considerable increase in exports to protected foreign countries since 1850, but practically none since 1870, that is, during the period when hostile tariffs began to affect our trade. Quite a different development is seen in the case of protected countries inhabited by our friends and relatives.

Unfortunately, the absence of information as to the earlier years of the period prevents detailed comparison of the returns for unprotected foreign and colonial markets, but the totals for each year are sufficiently conclusive as to the advantages afforded by the application of free trade principles to our exports. The unfortunate thing is that these privileges are deliberately and resolutely withheld by our foreign competitors.

This is the first point to which we invite the serious attention of our readers, and as to which we shall be glad to have the expression of their opinions.

TABLE V.

Exports of Goods manufactured or partly manufactured in the United Kingdom to the principal Protected and other Countries and Colonies.

(All Figures are given in Million £ units).

Year.	PROTECTED COUNTRIES AND COLONIES.			ALL OTHER COUNTRIES AND COLONIES.			
	Foreign.	Colonial.	Total.	Foreign	India.	Colonies.	Total.
1850	34·8	3·2	38·0	cannot be stated	—	cannot be stated	28·7
1860	55·0	6·8	61·9		16·0		62·9
1870	81·9	8·9	90·8		18·0		91·4
1880	83·4	9·9	93·3		29·1		104·8
1890	88·9	12·7	101·6	60·8	32·0	34·2	127·0
1900	82·4	12·0	94·4	59·6	28·5	43·1	131·2
1902	73·7	13·3	87·0	57·9	30·8	52·4	141·0

TRADE NOTES.

Large Shipments.

THE first two weeks of December last were marked with some heavy figures in telephone switchboard shipments. The American Electric Telephone Co., Chicago, during the period mentioned, turned out "express" switchboard equipments having a capacity of 2,000 lines, among which were boards to the number and line capacity as follows: one 300, three 200, and five 100 lines respectively.

Large Orders for the New York Central.

THE General Electric Co. have been given an order for eight turbo-generator units of 7,500 h.p. each, by the New York Central Railroad Co.; 30 electric locomotives of 2,200 h.p. each will also be supplied by the same firm. The number of units will be ultimately raised to 10 or 12 for the two power houses proposed. A contract for boilers awarded the Babcock & Wilcox Co. will amount to 48 boilers of 628 h.p. each, or a total of 30,144 h.p., superheaters being used in conjunction with these boilers.

Restrictions on Russian Electrical Imports.

FOURTEEN of the leading Russian manufacturing electrical establishments have addressed a petition to the Ministers of the Interior and Finances, requesting that the municipalities of St. Petersburg and Moscow be asked to order from Russian factories all electrical machinery and apparatus. It is hoped that the result of this petition will compel the municipalities to cease importing from foreign houses, and that all future contracts will be required by Government to be awarded to Russian factories. Germany is likely to be most seriously affected should this policy be adopted, but the fate of the petition will be watched with great interest by those American and English manufacturers who have previously supplied electrical apparatus for municipal plants.

The Production of Rubber.

THE Bureau of Commerce and Labour at Washington, has published statistics, showing that the production of rubber for 1900 was 57,900 tons, and for 1902 it was 54,000 tons—a decrease of 7 per cent. Brazil, Peru, and Bolivia, the principal rubber producing countries of South America, turn out over one half of the world's rubber out-put, and the figures for these countries indicate an encouraging increase. Africa, the other important rubber producing country, shows a decrease. The gatherers of rubber think nothing of the future, but merely collect the largest harvest with the least trouble, consequently their methods are exceedingly wasteful. With proper care the supply of rubber should increase rather than decrease.

Important Electric Railway Contract to a British Firm.

IN placing the order for 10,000 h.p. of machinery for its Park Royal power station, the Great Western Railway Co. has selected a British firm of long standing, namely the Electric Construction Co., Wolverhampton, to carry out the complete contract. The equipment comprises engines, three phase generators and condensing plant, for the electrification of the company's London suburban lines. The list of orders in this country for plant of this description has been too frequently marked with the names of American and Continental firms, consequently the recognition of the merits of an English company is worth recording. The example afforded by the Great Western Railway Co.'s action may well be followed in railway circles when large contracts for electrical apparatus come up for decision. The magnitude and character of the order are sufficiently indicative of its importance, and clearly show that we are able to produce high-class modern electrical machinery without having recourse to outside assistance.

L.C.C. Rails from British Steel Makers.

THE London County Council has at last decided to accept the offers of British steel makers for the track and slot rails, amounting to 12,500 tons, needed in re-constructing its tramways. Of the four contracts given out, the honours are divided between home and Belgian firms, the first and last orders being placed with British steel makers. The specification called for acid steel, and tenders were only considered which conformed to this requirement, and six tenders for basic steel were accordingly rejected. All the previous steel used has been of the latter structure, but a comparison on a large scale between the two classes was considered necessary, hence the decision to adopt acid steel. Several bids from firms were rejected on grounds of inability to deliver in specified time, and of unwillingness to accept the penalty clause. The successful tenderers were :—

Track Rails, etc.—Bolckow, Vaughan & Co., £43,748 9s. (Highest tender, £50,707).

Slot Rails, etc.—Frodingham Iron & Steel Co., £36,461 15s. (Highest tender, £49,755).

It is interesting to note that on the four contracts placed, £39,092—taking raw material as a basis—has been saved to the London ratepayers. The first contract figured at £7 5s. per ton, and the present one at £5 16s. 6d. per ton, the raw material in each case being 61s. 6d. and 54s. per ton respectively. Labour and other items were much the same, so it would seem that in the first instance British manufacturers were anxious to protect themselves.

Significant Figures of America's Electrical Exports. A Warning.

The Bureau of Statistics, Washington, issued some interesting figures as to the foreign commerce in electrical apparatus of the United States during October last, and also the nine preceding months in 1903. £86,135 of electrical machinery was sent abroad, and £89,754 of accessories, instruments and telephones, the figures for the previous year (1902) being £141,171 and £77,744 respectively. For the first ten months of 1901 and 1902, the figures for electrical machinery were £1,024,303 and £1,057,661 respectively, the corresponding months of 1903 being £893,456. Electrical instruments for that period of 1903 were £833,721, as compared with £718,183 in 1902 and £275,423 in 1901. For the two classes of apparatus the total for ten months of 1903 was £1,727,169, compared with £1,775,844 in 1902. Considering the prevalence of lower prices during the year, the figures speak well for the maintenance of the electrical export trade. These figures are worth consideration by the side of a warning to British manufacturers from Mr. Seymour Bell, British commercial agent, U.S.A., who prophesies deep inroads into our home markets by American firms. Strong indications of a decreasing demand in America for many classes of manufactured goods point to steps being taken to seek markets abroad for surplus products. Mr. Bell remarks, "It would be well to bring before British manufacturers and shippers in an unmistakable manner the progress made in recent years by American exporters in securing a hold on the markets within the British possessions, particularly for certain classes of goods which could be manufactured in the United Kingdom." He adds that during last year an increase of 17 per cent. in American exports to the United Kingdom is to be recorded.

Some Important Tramway Contracts of the Month.

Among the important contracts awarded in tramway circles during the past month, the following are worthy of comment:

The Maidstone Corporation, for the construction and equipment of its light railways, has placed the work in the hands of Messrs. Dick, Kerr & Co., for the sum of £18,871 3s. The contract for 7,000 tons of tramway rails, fishplates, and flange rails at Johannesburg has been secured by Bolckow, Vaughan & Co., at £40,000; Messrs. Hadfield's Steel Foundry Co. obtaining for the same tramways the order for the points and crossings. Messrs. Edgar Allen & Co., Ltd., through Messrs. J. C. White & Co., have been given the contract for cast-steel points and crossings, with tongues and renewable pieces, in their Imperial manganese steel, and cast-iron points and crossings, with manganese steel centres, for the Northampton tramways. Messrs. A. Krauss & Sons have awarded the same firm the whole of the cast-steel points required in the construction of the Sunderland district tramways. The British Westinghouse Company is supplying additional magnetic brake equipments for the Leeds Corporation Tramways Department; and the same firm secured the order for fifteen single-deck combination electric cars for Cardiff at £610 each. Messrs. Callender & Co. were the successful firm (out of seven who tendered) for supplying and laying tramway feeder mains in connection with the Bradford (Pershore Road) tramway scheme of King's Norton and Northfield District Council, their price being £3,076. The London United Tramways have given an order to the British Westinghouse Company for two 250 K.W. rotary converters and seven 100 K.W. oil insulated self-cooling transformers, switchboards, etc. Ten further tramcars, at £5,100, are to be supplied by Dick, Kerr & Co. to the Brighton Town Council; while other contracts in connection with these tramways are: 800 tons tram rails, £5,962, Bolckow, Vaughan & Co.; points and crossings, £2,023, Hadfield's Steel Foundry Company. The Swindon Town Council has placed contracts for its tramways as follows: J. G. White & Co., steel poles and overhead equipments, £4,164; the British Westinghouse Company, traction switchboards, £750; the British Insulated and Helsby Cables, Ltd., tramway feeders, £1,190. Dick, Kerr & Co. have also been given the contract for converting a further section of the Swansea tramways to electric traction at £11,345; while Callender's Cable Co. get the cables for the same work at £19,169. Quite a quantity of orders for tramway apparatus have gone to the British Westinghouse Company, for, in addition to the contracts mentioned above, they are supplying generating machinery for the Maidstone Corporation, complete magnetic brake equipments for for Bath electric tramways, and additional double-deck cars, with motors and controllers, for the Lowestoft Corporation tramways.

* *

The first 5,000 Annual Subscribers to *The Electrical Magazine* are being enrolled on special terms. As the list is being rapidly filled, early application is necessary to secure the particular privileges offered.

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

❧

INTRODUCTORY REMARKS.

By the ASSOCIATE EDITOR.

IN this section of *The Electrical Magazine*, our aim will be to discuss each month such matters as may arise in the political, social, and industrial worlds, having reference to the financial welfare of the electrical industry in the British Empire, and especially in the United Kingdom; or matters which show the effect of prevailing laws upon that industry, and indicate the need for reform or for amendment of the statutes. The question of legislation might, perhaps, be more properly put before that of the general financial prosperity of the industry; for that industry is created by the demand for electrical machinery and plant; that is, it is dependent upon the nature, number, and extent of the electrical schemes promoted in the country, and these schemes, again, are strictly regulated by Act of Parliament, so that, according as the state of the law encourages or discourages the promotion of these schemes, we shall find the electrical industry progressing or artificially checked. We say "artificially," because the advantages to a community of electric lighting, electric traction, and electric power are now so clearly proved and so generally recognised that, obviously, the electrical industry would, but for statutory restrictions, soon become one of the most important and most extensive industries in the country. We readily admit, of course, that the applications of electricity to public service, are such as to require some sort of regulation from Parliament, and accordingly we find no fault with the existence of laws relating to electricity. But it is one thing to have laws, and another to have good laws; and what we shall be chiefly concerned with in these pages, is the state of the law as we find it, to discriminate between the good in it which makes for progress, and the objectionable which tends to hamper progress.

ELECTRICAL LEGISLATION IN 1903.

As fresh legislative proposals are not brought forward every month, this branch of our subject may often be less prominent in our discussions than the other; but at the outset we may note briefly the different public bills, relating to electricity, placed before Parliament in 1903, and the result of the year's legislation. The proposals made in Parliament were in some respects of great importance, and attention has recently been drawn to them by the President of the Institution of Electrical Engineers, who devoted part of his Presidential address to this question of legislative reform. The measure which would have made the greatest change in the present law was that which sought to amend the Electric Lighting Acts by carrying into effect the recommendations of Lord Cross's Committee of 1898. It gave the Board of Trade authority to grant powers by provisional order for schemes of distribution of electricity in bulk to ordinary supply authorities; it also enabled undertakers to obtain lands for generating stations outside their area of supply, and to acquire such lands *compulsorily* under the Lands Clauses Acts. At present, under the Electric Lighting Acts, a provisional order can only give powers to acquire lands within the area of supply, and by agreement. Best of all, it abolished the veto now possessed by local authorities over all proposals for electricity supply in their areas. Thus, in effect, this bill would have made reforms which have been advocated for many years by all connected with the electrical industry, and which, nearly six years ago, were acknowledged by a Parliamentary Joint Committee as desirable and necessary. It is certainly disappointing that so long an interval should have elapsed before any attempt was made to grant these reasonable demands, but still more so, when an attempt was at last made, that the bill should merely be "introduced," and make no further progress. It must be made perfectly clear to the Board of Trade that promises alone in this matter will no longer be accepted, and that pledges already given will not be considered as fulfilled, merely by the introduction of measures which are not pushed on to an issue, and we are therefore glad that Mr. R. Kaye Gray, speaking officially as President of the Institution of Electrical Engineers, should have drawn public attention to the present unsatisfactory state of affairs, and demanded from the Government the performance of its pledges.

The other measures of last session bearing on our subject related to electric traction, and were two in number. The bill introduced to amend the Light Railways Act, 1896, did not really touch upon the points most in need of amendment. That Act has proved a great boon to the country, and has provided a means of nullifying to some extent the evils of the Tramways Act, 1870, but in the seven years since it was passed, various defects have appeared, and it was naturally supposed that in any fresh legislation these defects would be removed. Evidently, we must still remain content with what we have, for no serious attempt was made n the bill of last year to deal properly with the subject. We cannot regret that that bill made no progress in Parliament, for, had it been passed, it would probably have been used as an excuse for postponing further legislation to a still more distant date. In any case this legislation "by drops" is objectionable.

The remaining bill did eventually find a place upon the statute-book, and it remains the sole product of the year in public electrical legislation. The Railways (Electrical Powers) Act—so it is called—is intended to facilitate the introduction and use of electrical power on railways. Existing railway companies work under powers conferred by private Acts, and they cannot change from steam locomotion to electric traction without Parliamentary sanction for powers to that effect. The new Act provides cheaper and more convenient means of giving powers for such a change. The Board of Trade is now authorised to make orders permitting a railway company to:

(1) Use electricity in addition to, or in substitution for, any other motive power and for any other purpose;

(2) Construct and maintain generating stations on any of their lands;

(3) Make agreements with electricity supply authorities for electrical power, or the supply to and use by the company of any electrical plant or equipment;

(4) Modify any working agreement, so far as the modification is agreed to between the parties thereto, and is consequential on the introduction or use of electrical power;

(5) Subscribe to any electrical undertaking which will facilitate the supply of electricity to the company.

The applying company may appeal from the decision of the Board of Trade to the Railway and Canal Commissioners. There are other provisions in the Act, but those mentioned are the most important. It will be noticed that apart from the scope of its provisions, this Act is of interest as showing a growing inclination on the part of Parliament to allow its powers in matters of private legislation to devolve upon an outside tribunal. By the Light Railways Act, such a tribunal was created in the Light Railway Commissioners, with the Board of Trade as an appellate court. In the present case the Board of Trade is the court of first instance, but the appeal from that tribunal is not to Parliament but to the Railway and Canal Commission. We believe that nothing but good can come of this policy. A Parliamentary Committee works hard and usually does its work well, but in many cases it is ill-suited for the work it is called upon to perform, especially where technical matters are involved. Such matters are best left to experts, and there is the additional gain, that a special tribunal is less liable to be influenced in its decision by pressure from outside sources, a too common occurrence in the lobbies of the House of Commons.

If proper advantage is taken of the provisions of this Act, possibly not only the railways, but some of the large electric power schemes may benefit considerably. We cannot now say that the railway companies are likely to convert their main lines to electric traction at an early date; but branch and suburban line service may probably be improved and profits increased by the change. A branch line may more economically derive its power from a supply company in the vicinity than from generating stations of the railway companies, erected on each line. The Act provides for this, as we have seen, and it does even more; it makes it possible for the railway company to become a promoter of an electricity supply undertaking, or a shareholder in such an undertaking when authorised. Undoubtedly if this method were adopted, the power supply companies would have excellent customers in the electric railways in their area, and the economy in production thus obtainable would be a gain to all concerned. It remains now to be seen whether the railway companies with these new facilities given them, will seriously tackle the problem of electric traction on their branch and suburban lines.

THE FISCAL POLICY.

In our opening paragraph, we stated that any political questions bearing upon the electrical industry would come within the field we have allocated to ourselves in this section of *The Electrical Magazine.* We need scarcely explain that with purely party questions we shall have no concern. The question of the day, however, is happily not a party question. It is much too important, and affects the welfare of the nation and the condition of the people too closely to be allowed to be made a party question; and we are therefore free to touch upon it here, and to follow closely the attitude of the country towards it. It is not difficult to prove that this question has a great interest for all engaged in the electrical industry in the United Kingdom, for that industry has been one of the worst sufferers from foreign competition in recent years. With that part of the present agitation which is associated more particularly with Mr. Chamberlain—namely the question of preferential trading with our Colonies—involving the taxation of food, we are not so much concerned; but the policy now officially adopted by the Government, and supported by many who are opposed to Mr. Chamberlain's scheme, the policy of using tariffs upon foreign manufactures, as a means of bargaining with the countries from which these manufactures come, is on quite a different footing. Let us consider briefly its bearing upon our subject.

Throughout the civilised world, there is now a very large demand for electrical machinery and plant, and there ought to be a large export trade from this country in these manufactures. Had our electrical laws been wiser, there seems little reason to doubt that we should now have had a much stronger position in the world's markets than we actually have; but the checking of the natural rate of progress in the applications of electricity at home discouraged the growth of our electrical industry, with the result that, although the pioneers of modern electrical science were British, we were subsequently left behind in the practical development of the science by countries such as Germany and the United States of America. We must admit, then, that it is partly the fault of our domestic legislation that our position to-day is not better than it is; yet there are other reasons which must be taken into account. The foreign countries which are now our chief rivals, never gave us a chance of finding a market for our goods within their boundaries, but, by high protective tariffs, did all they could to foster home production and to keep out the foreigner. Who shall say that they did wrong in this? If we judge solely by results, everyone must agree that they acted wisely, for they are now in a position not only to supply the demand in their own countries, but to become serious competitors in this country with British manufacturers. Can it be logically maintained that we are not entitled to protect ourselves in the same way as they have done? Or, if it be admitted that we are entitled, can good cause be shown why we should not do so? Let any one go round our large municipalities and note the great amount of foreign plant used in their electrical enterprises; let him find the total amount of capital represented by that plant, the labour required for its manufacture, and the money spent in the form of wages on that labour; and let him then say whether it is a good thing for this country that all that money should be spent abroad rather than at home.

If retaliation were possible—that is, if we had a similar chance of obtaining foreign contracts—the position would be different, but this is exactly what we do not have. Further, competition is often made more unfair by the fact that our foreign rivals, in order to get a hold of the market in this country, quote prices which are unprofitable to themselves, trusting to their home profits to give them a balance on the right side at the end of the year. In this state of affairs, it may be an easy thing for some to say that we gain by obtaining what we require at a cheaper rate than if we had no such foreign competition, but the thousands of workmen who earn the daily bread for themselves and their families by assisting in the manufacture of similar goods in this country, will not take this optimistic view of the situation.

In recent years we have heard much of the need for business methods in our Government departments, and we cannot see why the same should not be applied to the regulation of our commercial relations with foreign countries. It is "bad business" to allow ourselves to be shut out from foreign markets, and at the same time to allow the foreigner to ruin our home trade; and for that reason we are disposed to favour the change of policy now being advocated by the Government. When definite proposals are placed before Parliament, they will be discussed and criticised in detail. For the present it is enough that the principle of retaliation has been adopted by the official government, but when the practical scheme is brought forward, we hope it will be found to contain an application of that principle to the case of the electrical industry. In view of the bad treatment it has received from Parliament in the past, it deserves to be considered at the earliest moment when the new *régime* is introduced.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A.

Cable Terminal Boxes for Electricity Supply Purposes.

G. Wilkinson, Bilton, Harrogate. No. 20,497. Dated 14th Oct., 1901.

This invention relates more particularly to cable terminal boxes commonly known as "house cut-out boxes," in which the supply cable or cables terminate, and from which the consumers cables derive their supply of electrical energy. The object of the said invention is to obtain reliable surface contact within the box, and efficient earthing thereof, by compression, and maintain the same by the expansive force of a spring washer or washers.

Claims.—(1) Cable terminal boxes in which the electrical contacts are made and maintained by the compression of a spring or springs, substantially as described.

(2) Cable terminal boxes in which the insulating and contact discs are secured and held in position by the compression of a spring or springs, substantially as described.

Alternate Current Motors.

V. A. Fynn, Manningham, Bradford. No. 22,712. Dated 18th Oct., 1902.

This invention provides an improved method for starting, operating and varying the speed of alternate current motors of the single or polyphase type, and is more particularly applicable to such motors as show the mechanical features of what are known as induction motors. It is well known that it is possible to obtain alternating currents of one, two, three or more phases from any direct current armature, whether revolving in a field produced by direct or alternating current or currents, by suitably tapping such armature.

In the construction of this motor, use is made of a direct current armature placed in an alternating field, and connected on one side to an ordinary commutator, and on the other to a number of slip rings, thus providing a motor which as soon as short-circuited brushes are placed on the commutator, and the alternating field is of the "stator" type, has the constructive elements of a non-synchronous induction motor, combined with the constructive elements of a repulsion motor. The number of slip rings depends on the currents required, being two when single phase is wanted, four for two-phase or rather quarter-phase, three for three-phase, and so on.

It is preferred to use at least three slip rings.

Claims.—(1) An alternate current motor consisting of the constructive elements of a non-synchronous induction motor, in combination with the constructive elements of a repulsion motor, for the purpose set forth.

(2) In a single phase alternate current motor for the purpose of starting and speed regulation, the use in combination with the type of windings herein described, of a commutator with suitably disposed and inter connected brushes, and of slip rings interconnected, as and for the purposes set forth.

(3) In a polyphase alternate current motor for the purpose of speed regulation, the use, in combination with the type of windings herein described of a commutator with suitably disposed and interconnected brushes, and of slip rings interconnected, as and for the purposes herein set forth.

(4) The combination with the elements claimed in Claims 1, or 2, or 3, or with the substitution of the winding, of an additional winding on the stator to supply the rotor with exciting current for the purpose of improving its power factor, said winding being placed in such phase relation to the main winding that the position of the brushes on the commutator which it entails corresponds with the best position of these same brushes for starting the motor.

(5) Similar to Claim 4, excepting that the position of the brushes on the commutator which it entails is such as to enclose between these brushes and those used for starting as much of the rotor winding as possible.

(6) The several methods and means herein described for starting the motor and regulating the speed thereof, and with or without the combination therewith of the means for improving the power factor, all in the manner set forth.

(7) The herein described means of improving the power factor by an exciting current derived from an auxiliary winding on the stator, in combination with means for varying the voltage of said current for the purpose of regulating the speed of the motor substantially as set forth.

Systems for Controlling Alternating Current Motors.

C. F. Scott, Pittsburg, U.S.A. No. 19,520. Date claimed for Patent under International Convention, 13th Sept., 1902. Date of application in the United Kingdom, 10th Sept., 1903.

This invention relates to the construction, operation and control of single-phase, alternating current motors in which commutators are employed, and in which a series relation, or its equivalent, is provided and maintained between the field magnet and armature windings. The object of the invention is to provide a means whereby the desired relation between the armature and field magnet windings in single-phase motors may be maintained, and, at the same time, a different amount of current may be supplied to the armature winding, from that which is supplied to the field magnet winding.

Claims. (1) In the operation of single-phase alternating current electric motors means for maintaining a constant ratio between the current in the armature and in the field magnet winding of the motor, and at the same time supplying said windings with different amounts of current.

(2) An arrangement for operating single-phase alternating current electric motors, in which one element of the motor is supplied from the secondary winding of a transformer included in the supply circuit, and the other element of the motor is either included in the supply circuit, or is supplied from another secondary winding on the transformer supplying the first element, or from the secondary of another transformer connected in series with the first transformer.

Magnetic Clutches.

E. A. Carolan, Cannon Street, London (a communication from the General Electric Company of Schenectady, U.S.A.). No. 26,379. Dated 29th Nov., 1902.

It has been found in the operation of magnetic clutches that considerable current is required to draw the two parts together owing to the magnetic reluctance of the air-gap between the members. Upon the coming together of the two parts there is a sudden decrease in the reluctance and a corresponding increase in the magnetic flux. As a result the two parts are suddenly locked together.

When one of the members is running and the other is stationary, this sudden locking shocks or jars the machinery being started, as well as that of the motive system. This is especially objectionable in the case where synchronous motors are employed to furnish the motive power as this jar tends to throw them out of step. The object of the invention is the provision of means whereby, when the two members of the magnetic clutch are drawn together, the attractive force between them will not be so great as to prevent a limited amount of slipping and hence engagement with the two members will take place without the objectionable jar above referred to.

Claims.—(1) An electromagnetic clutch having energising and holding windings, the magnetic circuit of the former having relatively large reluctance, so that approach of the clutch members does not substantially increase the attractive force between them, substantially as described.

(2) An electromagnetic clutch, as claimed in Claim 1, in combination with means for regulating the attractive force of the holding winding, substantially as described.

Automatic Electric Signalling Apparatus for Railways.

L. de M. de Labarthe, Toulouse, France. No. 27,056. Dated 8th Dec., 1902.

This invention relates to an automatic electric safety signalling apparatus for railways, for preventing collisions by preventing two trains running on the same line from approaching each other within a certain distance; the arrangement being such, that on a following train approaching the preceding train beyond the said distance, an audible or visible signal is actuated on the locomotive of the following train, advising the driver of the fact. The apparatus may, however, also be combined with accessory devices such, for instance, as a device for automatically advising the driver of a train of his approach to a set of points, so that he may reduce his speed accordingly, or a device in connection with a station advising a driver of his approach thereto; or again, there may be combined with the said apparatus supplementary signalling apparatus for single line railways for preventing collisions between approaching trains.

Claims.—(1) An automatic electric signalling apparatus for railways in which the current from a source of electricity is conveyed in succession to a number of subsidiary conductors grouped in sections by means of commutators operated by the passage of a train substantially as described.

(2) In apparatus of the kind referred to in the preceding claim, connecting the subsidiary conductors of one section with an electrically operated detent of the section in rear and thereby causing the subsidiary conductors of the rear section to be disconnected from the current supply, substantially as and for the purpose specified.

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers will be given.

◆

Electric Light and Power Distribution.

By W. Perren Maycock, M.I.E.E. Vol. ii. London: Whittaker & Co. Price 7s. 6d.

Taking this work for what it professes to be, namely, a text book for the preparation of students for examination in the Preliminary and Ordinary Grades of the City and Guilds of London Institute, we have perused it with interest. If anything may be said of it as a whole, we should say that it attempts to cover too much. This, however, is a fault probably not due to the author, but arising from the extensive syllabus of the examiners. On the subject of dynamo designing it would be better to confine the treatment to very elementary principles, and to adhere to symbols for "conductors in series on an armature," "the field strength," and the "revolutions or velocity of the armature," such as are commonly in use in standard works. It is not altogether correct to say that the E.M.F. depends on the "total length of conductor on the armature," as stated on page 43. The author seems to know better, for on page 44, in a foot-note, he explains that "the number of conductors in series" on the armature should be used, but, strange to say, on pages 46 and 47, in two examples, (b) and (d), he speaks of number of TURNS of active conductors. Thus the student has to choose between "length of conductor," "number of conductors in series," and "number of *turns*." "Number of conductors in series" is sufficiently comprehensive for all purposes. It should be made clear that with the same value of F. (total magnetic flux), the E.M.F. generated is the same, whatever the "length" of each conductor in series; and that the E.M.F. depends on "length" of conductors only when the induction, *i.e.*, lines per square inch or centimetre, is constant in the field. Passing on through "alternating current machinery" and "electricity meters," we find these subjects very clearly and well treated. We cannot, however, say the same of the handling of the electric motor; this subject can be much simplified for elementary students, and even for advanced students the long calculations on pages 324 and 325 are of no value. The motor is a reversed dynamo, and as such, the calculations for efficiency, speed, and torque, are easily made. The series motor is still held by the author to give a larger torque at starting than a shunt motor, an idea which has survived in many works from the early days of motors and dynamos made without any intelligent designs. Quite as great a torque can be got on a shunt motor as upon a series motor. It is the same for both, dependent only on current in armature and strength of field, and these can easily be made as great in a shunt machine as in a series machine. The simple starting switch, Fig. 187, is shown as it is sometimes used to finally open the field circuit on stopping the motor. This practice is bad, for the whole induced E.M.F. of the shunt coil will be thrown across between the break, between 2 and 3 contact. It is better to show the contacts 2 and 3 joined by another resistance R, so that the shunt is never opened, but remains closed through R.R.R.R. and the armature, when the contact is broken between 1 and 2. Fig. 194 however, shows this arrangement correctly, so that the student will see the difference. It is on the whole a very useful work, more especially for somewhat advanced students. The illustrations are numerous and well drawn, and remarkably correct. It can be recommended to students of engineering science in other branches who wish to acquaint themselves with the general principles and construction of electrical machinery, although not preparing for an examination. The exercising questions at the end of each section are well-chosen and practical, and are properly designed to test the student's progress as he advances through the subject.

The Slide Rule.

A Practical Manual. C. N. Pickworth, Wh. Sc. — 8th Edition. Emmott & Co., Ltd., London and Westminster. Price 2s.

The value of the slide rule as a physical aid to the mental performance of various arithmetical, algebraical and trigonometrical processes is now generally recognised, especially among electrical engineers. Those who would master its use and carry its functions beyond the ordinary computations needed in the theory and practice of electricity, into the higher calculations of algebra and trigonometry, which are equally necessary in technical electrical science, are recommended to follow the methods put forward by the author of this little work. Many useful examples for the rule in technical computations and trigonometrical applications are given, which should make the manual a useful book of reference. The edition before us is the eighth of a line of time-honoured predecessors, and has been considerably enlarged to meet the recent developments of slide rule methods. The Gravet or Mannheim rule is chiefly treated with, but new cursors and calculators of the Boucher type are also touched upon.

Electric Waves.

H. M. Macdonald. Cambridge University Press. Price 10s.

This is an Adams prize essay, and the author states in his preface that he has considered it sufficient to refer to previous workers, in general, only when dealing with special problems. This is to be regretted, as it would be a great assistance to the reader new to the subject. For example, in Chapter II., where the solutions obtained are those originally due to Poincaré, but derived by a different course of reasoning; and again, in

Chapter III., the subject of which has been treated very much more fully by Lorenz.

The author's first chapter is introductory. Chapter II. deals with the general equations of electrodynamics, the electric and magnetic forces being expressed in terms of convection currents, and based therefore on the electron theory. The method of treatment adopted involves the implicit assumption that Maxwell's ether displacement is independent of any motions of the ether, should such exist. Chapter III. deals with the electric force acting on convection currents in motion. It is pointed out that if the ether is assumed to be uniform, the presence of convection currents will always mean the presence of matter, which is to be regarded as due to singularities in the ether. In Chapter IV. the author criticises Maxwell's expression for the energy of the electro-magnetic field. Maxwell's first expression for this energy, in terms of the currents and vector potentials, is derived directly from Faraday's law. His second form he derived from this by a transformation giving the energy as the sum of a volume integral, taken throughout space, and a surface integral, taken over an infinitely distant boundary: the latter is assumed to vanish. The author shows that in the case of wave propagations, this surface integral does not, in general, vanish, but assumes an indeterminate value. The transformation is not, therefore, generally valid. It is this second expression for the energy which has led to the identification of the electro-magnetic theory of light with MacCullagh's optical theory, and hence to the identification of the magnetic induction with ether velocity, involving difficulties in connection with the effect of a magnetic field on the propagation of light, and also in connection with the properties of permanent magnets, and necessitating the further assumption that the ether density is infinitely great. The demonstration of the invalidity of the expression of the energy as a volume integral, removes these difficulties, as the electro-magnetic theory is then no longer identified with that of MacCullagh. It shows also, that Maxwell's dynamical theory, though sufficient for dealing with electric charges, is insufficient for dealing with motions of the ether. The author, therefore, in Chapter V., proceeds to develop a dynamical theory, starting with the expression of the Langrangian function in terms of the currents and vector potentials. He then compares the theory so obtained with those of other workers. The conclusion is arrived at that the existence of the potential energy function makes concealed motions essential to any dynamical theory of the ether. Chapters VI. and VII. are devoted to the discussion of the propagation of electric waves in simply and multiply connected spaces respectively. The author arrives at the conclusion that an indefinitely extended multiply connected space possesses modes of free, undamped, and therefore permanent, oscillations. This conclusion has been challenged both by Larmor and Pocklington, and W. Mc. F. Orr, in a paper published in *The Philosophical Magazine* last month, definitely disposes of it. The author, in a note to this paper, admits the disproof, and the consequent incorrectness of his conclusion. In Chapter VII. the author deals with electrical waves in thin wires on the assumption that they are perfect conductors. He appears to have overlooked the difficulty, first pointed out by Hertz, that the perpendicularity of the lines of force to the surface of the wire, which is the necessary consequence of this assumption, involves an infinite value for the energy of field due to a finite length of wire. Sommerfeld, in an investigation referred to by the author, has shown that this difficulty does not arise in the case of imperfect conductors, the logarithmic potential functions occurring in the first case, being replaced by Bessel functions. Radiation, including the case of the Hertz oscillator, is discussed in Chapter VIII. The conclusion arrived at, at the end of this chapter, that permanent waves can be obtained from a closed circuit is now abandoned by the author, as stated above. Experiments show the invariable existence of damping in the waves in closed wire. Moreover, the analysis given by the author in Chapter II. leads to the result that the waves emanating from the separate elements of a circular wire will interfere and destroy all radiation if, and only if, the dimensions of the circle are small in comparison with the wave length. Chapters IX. and X. deal with waves in open circuits, including the case of the Hertz oscillator. In both chapters the incorrect assumption is made that the radiation from an open circuit is confined to the free ends. This assumption is inconsistent with the analysis in Chapter II., and is a consequence of the incorrect conclusion that permanent waves can emanate from a closed circuit. It may also be pointed out that the results of this assumption are not in accord with Drude's measurements, made during 1902, of the wave lengths of the vibrations of a Hertz oscillator, nor with the measurements made by Kiebitz in Drude's laboratory in 1901. Four appendices occupy between 60 and 70 pages at the end of the volume. *A*. deals with the relations between theoretical and experimental physics. *B*. contains a further discussion of the dynamics of the ether and the nature of material molecules. *C*. gives a useful summary of recent work on the electro-dynamics of moving media. The last one, *D*, deals with diffraction, and though very short, is one of the most interesting and important portions of the book. After enumerating, with references to the originals, the cases in which solutions have been obtained of the problem of the diffraction of waves by a perfectly transparent body, the author gives the solution of a new case, that in which the diffracting body forms a wedge of any angle. The work forms an important contribution to an extremely difficult subject, and it is with the hope of smoothing the path of the reader, that the reviewer has devoted most of the limited space at his disposal to pointing out the existence of errors which, if undetected, would considerably detract from the usefulness of this very interesting volume.

BOOKS RECEIVED.

Electric Traction. J. H. RIDER. Whittaker & Co. 10s. 6d.

Modern Electric Practice. Vol. I. Blackie & Son, Glasgow. 9s.

Conduction of Electricity through Gases. J. J. THOMSON. C. J. Clay & Sons, Cambridge. 16s.

The Grant and Validity of British Patents for Invention. J. ROBERTS. John Murray, Albemarle St., W 25s.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whol will form an index guide of considerable importance and value.

* * *

Power.

Articles.

Some Electric Mining Appliances.	*Engr.* 13/11/03.
Engines for the L.C.C. Tramway Station.	*Engr.* 6/11/03.
•Transmission of Hudson River Power (Serial III. concluded).	*Elec. Wld. & Eng.* 7/11/03.
Factory Turbo Generator Power Plant.	*Elec. Wld. & Eng.* 7/11/03.
Central Station, Brussels, Tramways	*Elec. Rev. N.Y.* 14/11/03.
•Electric Power Transmission. A. Lionville	*L'Ind. Elec.* 25/11/03.
•The Aster Motor Generator Unit. G. A. Montpellier.	*L'Elect.* 28/11/03.
•Electrical Drive for Machine Tools. R. Lozier.	*Elec. Wld. & Eng.* 7/11/03.
Recent Developments of the Metropolitan Electric Supply Co.'s Installations (Serial, concluded.)	*Elec. Rev.* 20/11/03.
Blast Furnace Gas Power Plant at Ilseder Iron Works (Germany).	*Elec. Rev.* 4/12/03.
Oldham Electricity Works, Greenhill Station.	*Elec. Rev.* 4/12/03.
•Montreal, the Greatest Centre of Transmitted Power (1, Serial). A. D. Adams.	*Elec. Wld. & Eng.* 5/12/03.

Papers before Societies.

Combined Refuse Destructors & Electricity Works. S. D. Schofield	*Inst.E.E. Leeds.* 19/11/03.
Design of Modern Electric Power Stations. P. D. Ionides.	*Glasgow Univ. Eng. Soc.* 26/11/03.
•Regulation of Battery Motors for Dynamo Driving. •R. V. Picquous.	*Soc. des Ingenrs. de France.*

Traction and Transport.

Articles.

•Some Notes on Acceleration, Electric v. Steam." P. W. Dalton & Dr. J. Mannheim.	*Engr.* 6/11/03.
Wilkinson Overhead Tramway Accessories & Signalling System.	*Elec. Eng.* 6/11/03.
Submarine Boat "Protector"	*Engr.* 20/11/03.
Automatic Signalling on the District Railway.	*Engr.* 27/11/03.
Berlin-Zossen Railway Runs.	*Engr.* 27/11/03.
•Electrical Equipment of the Railway from Les Invalides to Versailles (1, Serial). A. Guéry.	*L'Eclair Elec.* 28/11/03.
•The Underground Electric Railway Power Station, Chelsea.	*Trwy. & Rwy. Wld.* 10/12/03.
Brakes for Electric Cars. W. Park.	*Trwy. & Rwy. Wld.* 10/12/03.

Papers.

Edison Accumulator for Automobiles. W. Hibbert.	*Inst.E.E.* 26/11/03.
Central London Railway. D. P Thomson.	*Rugby Eng. Soc.* 3/12/03.
Fiscal Policy in Special Relation to the Tramway & Light Rwy. Industry. Atherley Jones, K.C.M.I.	*Tramways & Light Rwys. Assoc.* 11/12/03.
*Electric Traction with Alternating Currents. A. C. Eborall.	*Inst.E.E. Manch.* 15/12/03.
*City & South London Railway, Working Results of the Three-Wire System applied to Traction, &c. P. V. McMahon.	*Inst.E.E.* 17/12/03.
Freight Development by Inter-urban Roads. E. S. Seixas.	*Street Rwy. Assoc. N.Y.* 6/10/03.
Storage Battery: its Underlying Principles, and the Causes of its Action. L. Lindon.	*Auto. Club of Amer.* 17/11/03.
Edison Accumulator. P. Janet.	*Soc. Inter. des Elect.*

Lighting & Heating.

Articles.

Some Points that Deter the Spread of Electric Lighting. F. H. Davis.	*Elec. Eng.* 13/11/03.
Candle Tests of Welsbach Burners.	*Electn.* 20/11/03.
How the United States Government Use Electricity. J. E. Price.	*Elec. Rev. N.Y.* 28/11/03.
Electric Arc. A. Blondel.	*L'Eclair Elec.* 5/12/03.
Radiation & Illumination (1. Serial).	*Engr.* 20/11/03.

Papers.

Practical Problems in Lighting & Illumination." W. D'A. Ryan.	*N.Y. Elec. Soc.* 30/11/03.

Telegraphy and Telephony.

Articles.

Electric Fire Alarm v. Automatic Sprinklers.	*Elec. Eng.* 6/11/03.
Swansea Municipal Telephones.	*Elec. Eng.* 13/11/03.
Independent Telephony in Great Britain (Serial). Gardner & Holme.	*Elec. Eng.* 13/11/03.
Telephone Engineering at Purdue University.	*Elec. Eng.* 13/11/03.

A Continental Overland Wireless Telegraph Installation. M. Albrecht.	*(Zeit. fur Elek.) Electn.* 13/11/03.
Concerning Wireless Telegraph Transmitters. L. de Forest, Ph.D.	*Electn.* 27/11/03.
*Relative Reliability of Wireless & Wire Telegraph Systems. R. A. Fessenden.	*Elec. Wld. & Eng.* 14/11/03.
*Methods of Signalling & Operating in Telephone Exchanges (1, Serial). K. B. Miller & C. S. Winston.	*Elec. Wld. & Eng.* 5/12/03.
Telephone Transmitters. A. V. Abbott.	*Elec. Wld. & Eng.* 5/12/03.
Cable Laying in Manila. A Trip Round the World. L. G. Martin.	*Elec. Rev. N.Y.* 14/11/03.
The De Forest Wireless Telegraphy System.	*Electn.* 4/12/03.

Papers.

Recent Telegraph Developments in Liverpool. E. J. Hidden.	*Liverpool Eng. Soc.* 2/12/03.

Electro-Chemistry.

Articles.

Glass Vessels and Quartz Vessels. Dr. J. Trowbridge.	*Elec. Rev. N.Y.* 14/11/03.
Electrolysis in Bridge Structures. G. T. Henshatt.	*Elec. Rev. N.Y.* 28/11/03.
Electro Deposition and Photography. T. Rieder.	*Zeit. fur Elek.* 19/11/03.

Papers.

Total and Free Energy of the Lead Accumulator. Dr. R. A. Schfeldt. (Adj. Dis.)	*Faraday Soc.* 8/12/03.
Bitumen in Insulating Compounds. D. A. Sutherland.	*Faraday Soc.* 8/12/03.

Electro-Physics.

Articles.

*Radio Activity (Serial, 1st article 23/10/03). F. Soddy, M.A.	*Electn.* 6/11/03.
Measurements of the Frequency of Very Rapidly Alternating Currents. J. W. Salomonson.	*Electn.* 13/11/03.
The Production & Uses of Ozone.	*Engr.* 20/11/03.
*Calculation of the Apparent Inductance of Armature Coils (1, Serial). C. C. Hawkins.	*Elec. Wld. & Eng.* 14/11/03.
Murphy High Potential Interrupter. A. F. Collins.	*Elec. Wld. & Eng.* 28/11/03.
Notes on X-Light (173 Serial). W. Rollins.	*Elec. Rev. N.Y.* 28/11/03.
Current Curves of Induction Coils. H. Armaquat.	*L'Eclair Elec.* 14/11/03.
Electron Theory and the Co-Relation of Physical Forces (1, Serial). T. Tomassina.	*L'Eclair Elec.* 21/11/03.
The Glow from Electrodes and a New Method of Spectroscopy. W. von Bolton.	*Zeit. fur Elek.* 19/11/03.
A New Cell for the Measurement of Liquid Resistances. M. Cantor.	*Zeit. fur Elek.* 19/11/03.
The Principle of the Voltametric Balance. G. Langheim.	*Zeit. fur Elek.* 19/11/03.

Papers.

*The Slow Registration of Rapid Phenomena by Strobographic Methods. E. Hospitalier, Foreign M.I.E.E.	*Inst.E.E.* 10/12/03.
Experiments on Eddy Currents. W. M. Thornton, D.Sc.	*Inst.E.E. Newcastle.* 14/12/03.
The Experimental Study of Stationary Electric Waves, with Special Reference to the Phenomena of Electric Resonance of Over-Tones. Very Rev. Monsgr. Molloy.	*Inst.E.E. Dublin.* 10/12/03.

Electro-Metallurgy.

Articles.

Production of Iron & Steel in the Electric Furnace. Dr. H. G. Smith.	*Zeit fur Elektroch. Electn.* 20/11/03.

Papers.

Notes on Aluminium Welding. S. Cowper-Coles.	*Faraday Soc.* 8/12/03.
Aluminium. Prof. E. Wilson.	*King's Coll. Eng. Soc.* 10/12/03.

Students.

Papers.

The Operation of Electric Lifts. H. Church.	*Inst.E.E. Students' Sec.* 2/12/03.
Artificial Draught as Applied by Fans to Steam Boilers. W. H. A. Robertson.	*Inst.C.E. Students' Sec.*
*The Training of an Electrical Engineer. Prof. F. G. Baily.	*Inst.E.E. Glasgow.* 8/12/03.

Manufacturers.

Articles.

Gravesend Borough Electricity Supply.	*Elec. Eng.* 6/11/03.
Isle of Thanet Electric Tramways & Lighting Co. B. Pontifex.	*Elec. Eng.* 20/11/03.
*Curtis Steam Turbine.	*Electn.* 20/11/03.
Ipswich Tramways.	*Elec. Eng.* 27/11/03.
A New Compounded Three-Phase Generator. E. Kolben.	*Elek. Zeit.* 8/10/03.
*An Important Method of Testing Large Generators under Full Load Conditions. By A. Behrend.	*Elec. Wld. & Eng.* 14/11/03.
*Testing Alternators under Full Load Conditions. W. H. Waters.	*Elec. Wld. & Eng.* 28/11/03.
*Shop Testing of Motors & Generators for Commercial Service (6, Serial).	*Elec. Rev. N.Y.* 14/11/03.
Richard Electrical Measuring Instruments.	*L'Elect.* 28/11/03.
Dynamo Construction in Germany (1. Serial). C. F. Guilbert.	*La Rev. Tech.* 25/11/03.
The Yorkshire Electric Power Co.'s Generating Station.	*Electn.* 4/12/03.
Works Visits. St. Helen's Cable Co., Warrington (1, Serial).	*Elec. Eng.* 4/12/03.

Papers.

Curtis Turbine.	*Rugby Eng. Soc.* 7/11/03.
*The Testing of Electric Generators by Air Calorimetry. R. Threlfall. M.A., F.R.S.	*Inst.E.E.* 26/11/03.
Electricity in Manufacturing Plants W. M. McFarlane.	*Soc. Naval Archts & Marine Engrs., U.S.A. Annual Meeting.*
Electrical Conductivity of Commercial Copper. L. Addicks.	*Inst.E.E. N.Y.* 20/11/03.
Steam Turbine Machinery. A. A, Wynne.	*Glasgow Tech. Coll. Sci. Soc.* 12/12/03.

Central Station Practice.

Articles.

Circulation in Water Tube Boilers.	*Engr.* 6/11/03.
The Choice of Watt Meters. P. McGahon.	*Elec. Wld. & Eng.* 21/11/03.
*The Combined Use of Alternating & Direct Current for Central Station Work. Prof. F. C. Caldwell.	*Elec. Rev. N.Y.* 28/11/03.

Papers.

*Methods of Charging for Electric Energy. E. H. Crapper.	*Inst.E.E. Leeds.* 17/12/03.

An Enquiry into the Working of Various Water Softeners. C. E. Strohmeyer & W. B. Baron.	*Inst.Mech.E.* 18/12/03.
*Comparative Behaviour of Floating & Booster Controlled Batteries on Floating Loads. L. Lyndon.	*Inst.E.E. America.* 20/11/03.
Some Remarks on the Willans Engine. J. H. Pocock.	*Glas. Tech. Col. Sci. Soc.* 28/11/03.
Mechanical Stokers for Electricity Generating Stations. A. Gay.	*Soc. of Engineers.* 30/11/03.
Super Heating. W. H. Booth.	*Glas. Tech. Col. Sci. Soc.* 5/12/03.
From Cotton Wool to Candle Power. The Evolution of an Electric Lamp. C. Wilson.	*Assoc. Engineers in Charge.* 10/12/03.

Electrical Work in the Shops.

Articles.

Making Accurate Index Plates. J. M. Stabel.	*Amer. Mach.* 5/12/03.
A System of Indexing for the Draughting Room. C. K. Harris.	*Amer. Mach.* 5/12/03.
A Filing and Indexing System for Drawings. E. C. de Wolfe.	*Amer. Mach.* 28/11/03.

Papers.

Experiments with High Rapid Cutting Steel Tools. Dr. J. T. Nicholson.	*Report to Manchester Assoc. of Engrs.*

Trade & Commerce.

Articles.

Some Statistics relating to Electrical Engineering (Serial concluded, 20/11/03). W. P. Digby, F.S.S.	*Electn.* 6/11/03.

Papers.

The Universal Exposition at St. Louis, U.S.A. G. F. Parker.	*Soc. of Arts,* 25/11/03.
Position of the Electrical Industry in Germany.	*Der Elek. Tech.* 30/11/03.
The International Trade Protection Union and its Significance for Austrian Trade and Manufacture. Report by Dr. Beck. (Continued.)	30/11/03.

Patents.

Articles.

Some Wireless Telegraph Patents (Serial concluded, 20/11/03).	*Electn.* 6/11/03.

◆

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

◆

THE TIME THAT A BUSY MAN WILL SAVE BY HAVING A CLASSIFIED LIST OF THE PRINCIPAL ARTICLES IN THE WORLD'S ELECTRICAL PRESS PERIODICALLY BEFORE HIM, AS PRESENTED BY *The Electrical Magazine*, CAN SCARCELY BE OVER ESTIMATED. AT A GLANCE THE READER WILL ASCERTAIN WHAT IS OF VALUE TO HIM IN HIS BUSINESS. *The Intelligence Department* OF *The Electrical Magazine* IS AT THE SERVICE OF SUBSCRIBERS FOR ANY FURTHER INFORMATION.

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, *with names and addresses of manufacturers, will be given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.*

◆

Power.

Dynamos and Motors.

D. BRUCE PEEBLES & CO., Tay Works, Bonnington, Edinburgh. A number of leaflets, got up in excellent style and bound in a neat cover, describe the dynamos and motors of this firm. Particulars of the various departments of their works commence the catalogue, and a complete specification of D.C. motors, ranging in size from 1 to 150 H.P. is given, together with a descriptive list of the same machines. Following on this is a specification of D.C. generators, 50 to 500 K.W., supplemented in a similar manner by a descriptive price list. The firm's specialities, in the shape of balancers for two and three wire systems, are also illustrated and described. Cranes, motors and controllers, motor driving pumps and fans, plating dynamos and geared motors go to complete an exceedingly well prepared price list. Further loose sheets, K and L, describe the three-phase alternators and motors manufactured by the Company.

ROYCE, LTD., Trafford Park, Manchester. This is a very neat catalogue, describing and giving prices of dynamos for belt, rope driving or direct connection to high speed engines. Standard designs are manufactured up to 350 K.W., for either traction or lighting service. C.C. motors of the open, semi-enclosed and enclosed types are manufactured in sizes up to 60 H.P. Balancers and motor alternators are also among the products of the firm.

ELECTROMOTORS LTD., Openshaw, Manchester. This Company has issued a complete catalogue and price list of its standard electro motors, for both high and low speeds and voltages. Some excellent illustrations depict the various applications of the firm's standard designs, for driving in almost any position. The motors are also shown coupled to fans, centrifugal and three-throw pumps, shafting, etc. Standard reduction gear is also included, the motors being fitted with a flanged, raw hide pinion on the armature shaft. A complete table of dimensions, weights and telegraph code for the motors is also given.

KEIGHLEY ELECTRICAL ENGINEERING CO., LTD. This Company's list contains full particulars of their dynamos, motors and motor starting devices.

Motor Applications.

JOHN GIBBS & SON, 72 Duke Street, Liverpool. The productions of this firm in the shape of air propelling and ventilating fans, driven by electro motors, are described in a booklet neatly bound in cloth. A safety inter-locking double pole quick break starting switch and resistance is also manufactured, to ensure absolute safety in starting motors. Dust-proof motors for machine driving are among the specialities of the firm.

Motor Starters.

THE SANDYCROFT FOUNDRY CO., LTD., Chester. This Company make a speciality of Woolliscroft's Patent Safety Enclosed Liquid Starting Resistance and Switch. This device forms the subject of a special catalogue. Full particulars and diagram of the switch are given and a card illustrating the method of connection is supplied. The device in question forms an interesting addition to the time honoured list of motor-starting devices.

ROYCE, LTD. The motor-starting devices of this firm are described in a separate pamphlet, which, in addition to the common type of starter, includes particulars of iron-clad controllers, hoist starting switches and shunt regulating resistances.

Cranes.

ROYCE, LTD. The crane catalogue of this firm has been prepared with considerable care and the result should well repay the labour expended upon it. Some unique illustrations of various designs of cranes, the Goliath overhead girder and jib types, are used to illustrate the booklet. In conjunction with these, a number of testimonials from users of these cranes are bound up in a neat form, and should add further testimony to the general appreciation expressed for this section of the Company's products.

Pulleys.

THE UNBREAKABLE PULLEY & MILL GEARING CO., LTD., Manchester. This firm make a speciality of the Ring Pulley, which they describe in a 4-page leaflet. The boss arms of the inner ring of this pulley are cast in one piece; it is then split in halves, the irregularity of the fracture making a close interlocking joint when the halves are bolted together. The boss is then bored and the ring turned on its face, to afford a true surface, on which the wrought iron ring is rivetted. Sizes of 10, 12, 14, 15, 16 and 18 inches diameter are made on this principle, two rings being used for pulleys over 10 inches wide.

Traction and Transport.

Accumulator Charging Accessories.

H. SNOWDON, 52 Queen Victoria Street, E.C. Nodon Electric Valve. This interesting form of rectifier for alternating currents is described in a pamphlet containing a detailed account of the device, together with a diagram of connections and sections, through various parts of the apparatus. A number of interesting curves recorded by the Ondograph, show the wave form of a rectified current when used for arc lighting, accumulator charging, etc.

Lighting and Heating.

Accessories.

THE GENERAL ELECTRIC CO., 71 Queen Victoria Street, E.C. Leaflet No. 104. Sections, F, S, K, L, O, for pasting into bound copies of G.E.C. catalogues.

A. P. LUNDBERG, 477 Liverpool Road, Islington, N. Electric Light Accessories. This list has been prepared in Mr. Lundberg's usual generous style, and sets forth in a number of neat illustrations and diagrams, the specialities he makes in the way of small switches, wall plugs, distributing boards, and ceiling roses. The "Century" type of switch still forms one of the most interesting products of the works.

Flexible Cords.

THE GENERAL ELECTRIC CO. Leaflet No. 1043. Omega Flexible Cords.

Arc Lamps.

ROYCE, LTD., Trafford Park, Manchester. A neat catalogue describing Royce vertical open and enclosed arc lamps gives prices and particulars of same. A section is also devoted to street lamp accessories, such as brackets and pole fittings. The Royce patent elevating gear is also described.

ARC LAMPS, LTD., 62 Old Broad Street, E.C. A descriptive brochure, illustrating the application of arc lamps of this firm in the streets of Cardiff.

Incandescent Lamps.

ROYCE, LTD. Leaflet describing the Royal Ediswan Lamp

Nernst Lamps.

GENERAL ELECTRIC CO. Leaflet S1045. This describes the Nernst Lamp for indoor and outdoor use, and includes some ornamental designs for shop lighting. A portion is also devoted to lanterns for street work. The prices of the lamps and accessories are given.

Radiators.

THE GENERAL ELECTRIC CO. Sheet E1046. A 5-page list giving prices and particulars of radiators of the Glow Lamp pattern. Radiators on the enamel system, with embedded resistance wires, are also given, together with particulars of curling iron heaters, hat pads, etc.

Wiring Conduits.

THE ARMORDUCT IMPROVED ELECTRIC CONDUIT CO., 5 St. Nicholas Buildings, Newcastle-on-Tyne. Price leaflet of Armorduct "Extra Heavy" conduit for high-class installation work, in breweries, chemical works, public baths, dock and harbour works, etc. The junction draw-in and T boxes for this gauge of tubing are also described.

Telegraphy and Telephony.

Telephones.

GENT & CO., Faraday Works, Leicester. Among the specialities of this firm is the Parsons Sloper Patent Direct Call Secret System of inter-communication telephones. Full particulars of this system, for use especially in offices and works, are given in an interesting booklet prepared by the Company.

Electro-Physics.

Oscillographs.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., Cambridge. The Duddell Patent Oscillograph is described at length in a substantial catalogue, issued by this Company. The principles upon which the instrument has been designed are clearly set out, the description being illustrated by concise diagrams, photographs, etc. Prices of the various types are also given. The catalogue is concluded by many examples of curves drawn by the aid of the apparatus, among which two interesting records are included, showing the effect of switching on and off a high tension feeder.

Students'.

Drawing Office Appliances.

W. WATSON & SONS, 16 Forest Road, Edinburgh. The Raymond-Barker Calculator Board. This interesting device, the invention of Mr. E. Raymond-Barker, M.I.E.E., forms a valuable addition to the list of appliances to facilitate the use of graphic methods of calculation. The 4-page leaflet issued by the firm gives some examples of its employment. The prices are also given.

Manufacturers'.

Gearing.

DAVID BROWN & SONS, Lockwood, Huddersfield. An elaborate production in the catalogue line emanates from the above firm, and deals specifically with every class of gearing, from spur to spiral. The illustrations throughout are of a superb character and graphically depict the particular gear shown. In addition to the descriptive matter, a number of valuable tables are given, dealing with the circular pitches of cut gears, pitch angles for bevel wheels, etc. The firm make a speciality of cut gears for traction work, and raw hide pinions, in fact almost every class of gearing seems to be within the scope of its products. The booklet should be in the hands of every manufacturer.

Central Station Practice.

Economisers.

E. GREEN & SON, LTD., Wakefield. Messrs. Green have issued an excellent booklet dealing with their economisers and the particular accessories used in conjunction therewith. It contains a mass of valuable information and should be in the hands of every central station engineer. Tabulated particulars are given of the dimensions, capacities and heating surfaces of economisers, and some useful rules are included, which will be of value to engineers considering the extension of this important section of the boiler-house plant. Some important suggestions are put forward for the working of economisers, and a diagram is included showing how to withdraw and replace a damaged tube. A sub-section is devoted to the use of the economiser in large power stations, for the supply of energy to tramways and railways. Another portion deals with Messrs. Green's boiler feed pumps, and engines and motors for driving the scrapers. The booklet concludes with a number of excellent plans, setting forth in a concise manner various arrangements of the economiser in conjunction with water tube and Lancashire boilers. The entire production is well worthy the reputation Messrs. Green have established for their specialities in this direction.

Boiler-House Accessories.

HOLDEN & BROOKE, LTD., Sirius Works, West Gorton, Manchester. A substantial book dealing with ejectors, feed water heaters, steam dryers, oil separators, steam traps and pumps, and valve fittings, etc. The arrangement includes a thumb index, forming a handy guide to the main sections of the catalogue. The firm's specialities are illustrated both in diagram and sectional wash drawings, which clearly set out every detail of construction. Prices also are given in each case. The edition has been got up in a systematic manner, as all illustrations are given a number, the quotation of which will indicate the apparatus in question, there being no necessity to mutilate the catalogue.

Machine Tools.

Frank Pearn & Co., Ltd., West Gorton, Manchester. This Company has compiled a descriptive booklet, giving details of their facing and boring machines. These are of special value for pipe work, and can be used for every species of valve, elbow, U piece, etc. The machines, of which two sizes are made, should fill a long felt want in the workshop of any central station, where pipe work and fitting of a kindred character is carried out on the premises. The prices are set out on a separate sheet.

Distribution.

Cables and Mains.

The Howard Conduit Co., Trafford Park, Manchester. This Company has issued a very neat booklet, the outline of which resembles exactly a section of the conduit they manufacture. In this form it cannot fail to find a place on the table of every mains engineer. Among the specialities of the firm is a flexible troughing, and those cable engineers accustomed to the patch-work of wood casing, should appreciate the value of this design of conduit. The confidence of the makers in the insulating properties of their product, is exemplified by the challenge they issue, and which we reproduce herewith. "A length of bare copper to be laid in the troughing, as in practice, the copper to be within half an inch of the outer surface, the whole immersed in water at 120 lbs. pressure per square inch, for six weeks, and then to show 300 megohms per mile insulation resistance, and to withstand a pressure of 35,000 volts for five minutes." Some useful information on suitable sizes of troughing, for various combinations of cables, is also included.

House Service Boxes.

Keighley Electrical Engineering Co., Ltd., Vulcan Works, Keighley. A descriptive booklet containing full particulars, prices and diagrams of house service boxes, fuse boxes and street service boxes. The Keighley Patent Fuse Carrier, and Lamp Pillar Switch, are also described in detail. The diagrams of the connections of the service boxes are very clear, and would prove of value in the office of any mains engineer.

Consumers' Accessories.

Prepayment Meters.

Geipel & Lange, 72a St. Thomas Street, S.E. A 2-page leaflet, describing the Vulcan Watt-Hour Prepayment Meter for continuous or alternating currents. A description of the meter and instructions for installing, together with prices of the various sizes are given.

A.C. & D.C. Meters.

Ferranti, Ltd., Hollinwood, Lancs. This pioneer firm has issued an interesting brochure of its latest production, in the shape of an alternating current meter. This is fully described in our Manufacturers' Section, on page 77. The pamphlet gives full details of the construction of the meter, together with a list of the standard sizes for which the meter has been designed, and details of each size. The same firm has supplied us with a pamphlet on its continuous current meters, and this is also profusely illustrated with explanatory diagrams. This meter has been on the market for many years, and has obtained a good reputation during its commercial exploitation.

Miscellaneous.

Belting.

The Lancashire Belting & Hose Co., Ltd., Manchester. A descriptive booklet giving prices and particulars of the specialities of the firm in the shape of hair belting for driving dynamos, amongst other apparatus. The pamphlet opens with the true history of fabric belting, and indicates the work of the firm in question in producing their particular type of belting, which was patented as far back as 1860. A second quality hair belting is manufactured, in addition to a combination belting (hair and leather), cotton, leather, india-rubber and canvas belting. Canvas and leather hose and vulcanised india-rubber for insertions, etc., are also among the specialities of the firm. The approximate weights of belting and some useful hints on the jointing of belts are also included.

Machine Paints.

Griffiths Bros. & Co., Mack's Road, S.E. This firm has issued a small catalogue giving particulars of their paints and enamels for finishing machinery, and an excellent selection of tints is offered. Other specialities, such as Armallac, Armacell Insulating Varnish, Discum Varnish and anti-sulphuric enamels, are among the specialities of the firm.

Forthcoming Events

A complete list of meetings of the various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, will be listed under order of date in this section.

❧

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

April 30th to December 1st, 1904.

Electrical Exhibition, Warsaw.

May to September, 1904.

Third International Congress of Mathematicians, Heidelberg.

August 8th to 13th, 1904.

Industrial Exhibition, Cape Town.

November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

The date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition. The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

Papers before Societies.

I.E.E., Leeds Section.

Alternators in Parallel, by H. Bohle, A.M.I.E.E. *January 21st.*

I.E.E., Glasgow Section.

The Hiring of Motors for Corporation Supply, by S. E. Britton. *February 9th.*

I.E.E., Manchester Section.

Steam Turbines, by W. Chilton. *February 2nd.*

Coal Consumption in Central Stations, by A. S. Giles, M.I.E.E. *February 9th.*

Manchester Tramways Equipment, Line, and Rolling Stock, by J. M. McElroy. *February 16th.*

Meetings, Conventions, etc.

I.E.E., Glasgow Section.

Visit to the Works of Messrs. Bruce, Peebles & Co. *February 13th.*

I.E.E., Manchester Section.

Annual Dinner. *February 26th.*

American Electro-Chemical Society, Washington.

April 7th, 8th, 9th, 1904.

National Electric Light Association.

27th Annual Convention, Boston. *May, 1904.*

Books.

Modern Engines and Power Generators, by Rankin Kennedy, C.E.

Radio-Activity, by Fredk. Soddy, M.A.

The Electric Club Journal. First Number February 1st.—The Electric Club, Wilkinson, P. A.

The
Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

No. 2. Vol. I. London. February 25, 1904.

Success

beyond expectations has crowned the publication of the first issue of *The Electrical Magazine.* The demand has been of an extraordinary character, and I can safely say that the number printed and sold represents a much larger total than the circulation of any other technical monthly, and—for that matter—of any engineering weekly, electrical or otherwise. That this circulation will be of a permanent character is evidenced by the formidable list of subscribers, which has been rapidly growing since the publication of No. 1. I hardly know how to thank my numerous readers and the press of the United Kingdom for the whole-hearted and spontaneous support which has been accorded this venture. It would be a matter of physical impossibility to reply individually to all those who have so warmly written me their appreciation of the Magazine, but I take this opportunity, in the second issue, of publicly recording my sincere gratitude for all the kind things that have been said, with my assurance that the encouragement thus afforded will act as the strongest possible incentive to me and my staff in our endeavours to make the Magazine of increasing value and importance to the great interests which it has been established to serve.

I feel that it will not be out of place at this moment, or encroaching unduly upon the time of my readers—which it is one of the main objects of this journal to save—to furnish a few instances of the way in which the Magazine has been received, and incidentally to briefly indicate future contents and intentions. In this latter connection, I may say that the special articles which will appear in the next and forthcoming issues will, I am assured, possess an unparalleled interest for electrical men and all who are in any way associated, even remotely, with electrical work and practice. Arrangements have been made with a number of writers of the highest repute to contribute important matter of an absolutely original character, exclusively to this publication, and this matter will be profusely illustrated, from drawings specially made, or photographs expressly taken, for this journal.

In regard to the specialized sections, I may say that these, and in fact the whole Magazine, will be improved and strengthened month by month in the light of working experience.

Let me strongly urge one point. Although I claim that this Magazine is the most comprehensive compilation that has seen the light in electrical periodical literature, it is not possible, as all thinking men will concede, to present *everything* that *everybody* would like to have recorded, within the compass of a single journal; this would need a book which, by its very unwieldiness, would defeat its own purpose. What I have essayed to produce is a journal which, apart from its original matter, will either give a *precis* of, or reference to, as much of the best of the world's electrical thought, investigation and work as will be of maximum value and interest.

Dealing now with the way in which the Magazine has been received, I may say without exaggeration that I have been literally inundated with letters from men in every walk of life more or less identified with the electrical industries. Not a single adverse opinion has been advanced. The letters show the most extraordinary unanimity, and come alike from artisan, manufacturer and eminent scientist. I am particularly pleased with the fact that students in our technical colleges and pupils in electrical works are taking the Magazine very largely and showing great interest in its welfare. In this connection, I intend making a special effort on behalf of the rising generation of British electrical engineers through the Students' Section of the Magazine, and in regard to artisans, I have an important scheme in hand which I shall refer to in a later issue. In the meantime, I would suggest that all readers interested in the matter of Workshop Practice should keep their eyes upon this particular section. May I impress upon manufacturers that what advantages the man benefits the master.

I offer no apology for recording in these pages a few opinions which have been received, among hundreds, from representative men and leading organs of public opinion. They will surely have an interest for all those who are so earnestly supporting this Magazine.

In conclusion, I cordially invite correspondence, suggestions, and information from readers. The staff of the paper is now in a position to deal with anything and everything that comes along. Co-operation of the right sort will assist me all the quicker to make this publication the force I intend it to become in the interests of the British electrical industries.

Theo. Feldon

What is thought of The ELECTRICAL MAGAZINE.

Some Typical Opinions.

Amongst a host of other notable men, Dr. J. W. SWAN, M.I.E.E., &c., says:—

"The first number of your Magazine is excellent."

From the United States comes the opinion of Mr. CARL HERING, M.Amer. I.E.E., of Philadelphia, who says:—

"There is room for a publication of the kind."

In a letter from Switzerland, Mr. EMIL HUBER, of the Maschinenfabric Oerlikon, says:—

"Your Magazine pleases me very much and I desire to subscribe to it."

Mr. SHELFORD BIDWELL, M.A., M.I.E.E., &c., is of opinion that the Magazine

"Contains a large quantity of very interesting matter."

Mr. W. D. KIRKPATRICK, A.I.E.E., of Liscard, says:—

"A first rate publication, better than anything previously issued of its kind."

Mr. GEO. J. GIBBS, M.I.M.E., of Preston, is of opinion that the Magazine is

"Remarkably well schemed."

Mr. A. B. MOUNTAIN, M.I.E.E., Corporation Electric Supply Station, Huddersfield, thinks that

"The Magazine is exceedingly interesting."

Mr. TYSON SEWELL, A.I.E.E., of London, records his view that the Magazine is

"A great success."

Mr. PERCY R. ALLEN, of The Castner Kellner Alkali Co., Ltd., Runcorn, says:—

"An interesting and acceptable organ to the profession."

Mr. H. E. SHARPIN, of Preston, says:—

"It supplies a long felt want, and is *far away* the best Magazine of the kind I have ever read; it is quite certain to be a *great* success."

Mr. W. E. HEYS, of Watford, says:—

"I most sincerely wish you the great success you deserve, for an absolutely impartial journal dealing with the technics of electricity has been very much needed."

Mr. THOMAS E. BAIRD, of Glasgow, records his opinion as follows:—

"The first issue of *The Electrical Magazine* is an excellent production and certainly deserves success, it is well printed and has the appearance of completeness which few publications of journals of a trade nature ever attain, while the matter it contains is certainly well written and full of interest. Wishing you every success."

Mr. C. ARTHUR PEARSON, the well-known Proprietor and Editor of the *Daily Express* and other newspapers, writes:—

"Dear Mr. FEILDEN,—I have looked through *The Electrical Magazine* with interest. It seems to be a capital thing and should be very valuable to those who are engaged in this great industry.

Yours sincerely,

C. Arthur Pearson

From Well-known Firms:—

Messrs. E. GREEN & SON, Ltd., of Manchester, say:—

"A useful addition to the current Electrical literature."

Messrs. ISAAC STOREY & SONS, Ltd., of Manchester, in a cordial letter, say:—

"We wish you every success."

The NORTH EASTERN STEEL CO., Ltd., of Middlesbrough, are of opinion that

"*The Electrical Magazine* will be of value to those engaged in the trade."

CLARKE'S CRANK & FORGE CO., Ltd., Lincoln, welcome the advent of the first issue of the magazine

"With pleasure and interest."

Mr. GEO. M. MOORE, manager of The Williams Typewriter Co., for Europe, says:—

"It is the finest piece of Magazine work I have seen, either here or in the United States."

Messrs. TEMPLER & RANOE, Ltd., of Coventy, express the view that

"Without doubt there has been a distinct want for such a Magazine, and its value will be great to the Electrical world."

From some leading Daily Papers :—

The Morning Post :—

"We are glad to welcome the first number of *The Electrical Magazine*, which promises to be a most useful publication. The need for such a magazine as this is proved. The number is excellent. *The Electrical Magazine* deserves success, and has every right to expect it."

The Daily Express :—

"The increasing popularity of electricity finds expression in *The Electrical Magazine*, edited by Mr. Theo. Feilden. The success of the first number has been so great that a second edition is now issued. The magazine will champion British interests against the unfair foreign competition with which all electrical work has to contend."

The St. James's Gazette :—

"In Mr. Feilden's latest publication all interested in the progress of electricity and the perfection of electrical appliances will find a most useful guide and review. The editor of *The Electrical Magazine*, of which the first number is just published, enjoys the co-operation of a number of the highest authorities on the subjects dealt with. The paper and printing are excellent, the illustrations numerous and artistic, while a special feature in the scheme of the periodical is that the whole of the subject matter is sectionised for ready reference."

The Citizen :—

"*The Electrical Magazine*, edited by Theo. Feilden, has been called into existence by the surprisingly rapid growth of electrical industries, and should be eagerly welcomed by professional men and others interested in electricity. Many well-known names will be found on the list of contributors, and a glance at the magazine shows that its claim to have effected a revolution in electrical literature is not a mere boast."

The Evening Times (Glasgow):—

"Mr. Feilden's first number is comprehensive, but well arranged and informative. If *The Electrical Magazine* fulfils the promise of its first number it will be not only a success from the point of view of its promoter, but also a valuable accessory to the daily work of the electrical engineer."

The Sheffield Telegraph : -

"Mr. Theo. Feilden, the late editor-in-chief of *Feilden's Magazine*, enters the field with a new journal entitled *The Electrical Magazine*. It represents a radical departure in technical journalism, and will present, in concise, sectionised form, all that is transpiring in the world of electrical enterprise. The scheme of the magazine, which makes an excellent start, includes the sectionising of the whole subject in a form suited to ready reference; and this idea has been effectively carried out. Upwards of 150 gentlemen prominently identified with electrical industries are financially interested in the journal."

The Observer (Warrington):—

"The new magazine is essentially a time-saver. Every branch of electrical work is separately considered and sectionised, and each section has a leading expert for its associate editor. It is a veritable record and compendium, concise, yet comprehensive, and we imagine will fill a want long felt by the busy man in the world of electricity."

From other Important Journals.

Commercial Intelligence :—

"Mr. Feilden's new monthly *The Electrical Magazine* will meet with a cordial reception on all hands. It deserves to, judging from the initial issue. Consisting of over 160 pages, and fully illustrated, it is wonderful value. Every branch of electrical work is separately considered and sectionised, each section having a recognised expert for its associate editor. Thus the entire electrical field is covered on novel lines. We are specially pleased to note that the general tone of the articles is "militantly British," for there is a lamentable dearth of stalwart supporters of the claims of British industry among our electrical and engineering press."

The Middleton Guardian :—

"*The Electrical Magazine*, edited by Mr. Theo. Feilden, will take its place amongst the foremost of our monthlies. The first number, now to hand, is full of information useful to the craft, and the fact that the first edition ran out at 10,200 copies shows that it is appreciated."

The Watford Observer :—

"In connection with the Magazine, an Intelligence Department has been established, which will be of considerable service to the electrical fraternity of the United Kingdom. In this connection a somewhat unique offer is made to annual subscribers."

The African Review :—

"We welcome the first issue of *The Electrical Magazine*, brought out under the auspices of Mr. Theo. Feilden, late editor of *Feilden's Magazine*. It is, without question, a splendid number, and must appeal very strongly to the growing multitude concerned with the theoretical and practical development of electricity. In an explanatory note Mr. Feilden explains how he has devoted two years of thought and organisation to the venture. Very wisely he recommends the phrase—we be-one of Lord Bacon's—"to make haste slowly" in journalistic issues. In any case, Mr. Feilden has laid a very solid foundation for the journal's future to rest upon. He has enlisted the sympathies, the services, and the active support of most high authorities in the electrical world. The first edition is stated to have consisted of 10,200 copies; the one before us being marked already "Second Edition." If the standard of the present number is maintained, we should say so will its present success."

The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

❧

This section will consist of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They will be mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

❧

War!

ELECTRICIANS will follow the events in the Far East, more with a view to ascertaining the particular utility of electricity in manipulating battleships, the firing of mines, and in methods of communication rather than the strategical movements of the campaign. The occasion will be one of extreme portent to electrical men, and will probably decide the future employment of electrical energy in the heavy engineering branches of modern warfare. We also anticipate the extended use of wireless telegraphy in the operations, while records in telegraphic despatch over the eastern lines will doubtless be established.

❧

Kismet!

A FLY in the carburetter of a petrol vehicle will bring it to a standstill, and has done before to-day, under exasperating circumstances. That a block in a feed pipe should occasion the shut down of a large electricity works seems like the irony of fate, but judging by the latest reports, such an occurrence threw Huddersfield into darkness recently for several hours. The wisdom of supplying trams from an independent station was pleasantly welcome in this case, as the car service continued merrily through streets temporarily bereft of their brilliance. Truly electrical engineers are victims of circumstances.

Tesla as a Consultant!

NIKOLA TESLA has again sprung a surprise on the electrical world by announcing his intention of entering the field of professional consultants. Mr. Tesla is a scientist whose researches have ever commanded the attention and respect of his *confreres*, consequently his latest step must be regarded as a laudable effort to reduce to practical form the results of his many investigations, unusual though the course he has adopted may be. That he will secure an influential *clientèle* we do not doubt, and setting the sensational aside, we anticipate some concrete examples of progress as the result of this, his latest effort.

❧

A.I.E.E. Annual Dinner.

THE annual dinner of the American Institute of Electrical Engineers was judiciously arranged to be held on the twenty-fifth anniversary of the successful introduction and perfection of the incandescent lamp, and also on Mr. Edison's birthday. The latter gentleman was the guest of honour, and the event was further made the occasion of the presentation to the Institute of the medal fund and deed of gift of the Edison Medal Association. Mr. Edison refused to speak, but responded to the toast in his honour by a telegraphic acknowledgment which he tapped out on one of the original quad sets built by him for the Western Union Telegraph Co.

Sir Frederick Bramwell. DEATH has been terribly busy among the ranks of electrical engineers recently. Apart from minor men, three distinct personalities have been removed from their earthly labours in comparatively quick succession, and, strange to relate, all of these were, more or less, intimately connected with *The Electrical Magazine*. The first to go, Sir Frederick Bramwell, was one of the earliest supporters of this publication, and his belief in its future took tangible form. Sir Frederick was a shareholder in the company owning *The Electrical Magazine*, and we were fortunate, in the inception of the paper, in having the benefit of his great experience in many useful suggestions. Apart, however, from his practical help, the Editor of this journal, as many others did, lost a genial, kind, and much valued friend when the venerable face of Sir Frederick passed from mortal ken. This is the first opportunity we have had of publicly paying a tribute to the memory of a man who, despite the opinions held by many in regard to what they were pleased to term his "idiosyncrasies," was ever, in our experience, the true, cultured, upright English gentleman.

* * *

R. C. Quin. THE second loss to the electrical profession and this magazine was tragically sad in its intensity. For poor Quin to be snatched into eternity by the sea whilst standing apparently safe, directing the work which his brain, enterprise, and energy had practically carried through, was too awful for words. It was only a short time before, that the Editor of *The Electrical Magazine* had had an interesting conversation with him in regard to the plan of this paper, in which he held a proprietary interest. Had Mr. Quin lived he would doubtless have risen to the highest honours in the profession he adorned. His ideas and views were always full of sound common sense, and he advocated them with the enthusiasm of youth—he was only 38. Born in London, in 1865, Mr. Quin was educated at a public elementary school, and having definitely adopted the profession of an engineer, made rapid progress therein, securing in 1886 his first appointment under the Bradford Corporation. The Brighton undertaking claimed his assistance in 1891, and Blackpool welcomed him as chief in 1896. Many and arduous were his labours while at the head of affairs, not the least being the conversion of the old conduit line,—the first of its kind in the country—to the overhead trolley. We recall a remark of his at the Huddersfield meeting of the Municipal Electrical Association, when parallel running was under discussion, how in spite of the diverse character of the plant under his charge, rope, direct and turbine driven, he said, "I run them all in parallel." The incident, unimportant in itself, is, we think, significant of the man and his methods. Subsequent to his resignation he followed more closely that consulting practice which it had been his privilege to engage in while with the Blackpool Corporation. At the time of his death Mr. Quin was following this consulting work, in a private capacity, as partner to Mr. J. W. Speight, with whom he had engineered several important electricity works. By his untimely death the electrical world loses an ardent advocate, and the *personel* of *The Electrical Magazine*, a valued collaborator and staunch adherent.

* * *

W. G. McMillan. THE death of Mr. W. G. McMillan came as a great shock to us and the many friends and admirers of a man who occupied a post in the electrical arena which will be hard to fill. As a personal and much valued friend of the editor of this publication he is sincerely mourned, and his loss will be keenly felt far beyond the confines of the Institution of Electrical Engineers. His associations with electricity and applied science were marked with speedy and prolonged success, and in the chemical world he established himself as an authority on metallurgical subjects. Many valuable books and translations have emanated from his pen, while he held positions only available to acknowledged experts in the world of chemical research. The records of the Institution of Electrical Engineers during the six years he was secretary of that body are a living testimony to his untiring energy and his ardent prosecution of duties, which must latterly have been of a most onerous character. The organisation of the Local Sections of the Institution and the excellent arrangement of the Continental visits—the latter a feature of the Institution programme—must always prominently recall his unflagging exertions and grasp of details. His geniality, tact and unfailing courtesy were proverbial. To the members of his family we extend our sincere sympathies, while regretting deeply the removal of a prominent figure from our midst. We are pleased to hear that the Institution authorities have started a memorial fund, to which we anticipate a hearty response.

THE LATE W. G McMILLAN.

Further Losses.

In addition to the three well known figures in electrical circles to whom we pay tributes above, we have to record with regret the death of Friedrich von Hefner Alteneck, whose name was associated with the early developments of drum armatures. His standard candle has many advantages, and the amyl-acetate lamp has been but little altered since its introduction in 1880. For more than twenty years he was with Siemens & Halske, and in 1890, when illness compelled him to relinquish his duties, he was head of their technical staff. With Jablochkoff's works he was thoroughly familiar, and to a younger generation lacking his wide experience he pointed out that Jablochkoff & Nernst had nothing in common.

We also regret to record the death of Mr. Ernest Thompson, joint managing director of Nalder Bros. & Thompson, Ltd., a firm which has established a world wide reputation as instrument makers. Mr. Thompson became an assistant with Nalder Bros. & Co., in 1893, and in 1896, when the business of that firm was divided, became co-partner with Mr. Nalder, in developing the ammeter, voltmeter, and switchboard section of the concern. Truly death has reaped a rich harvest among electrical men lately.

◆

Amercian Association for Advance of Science.

In conjunction with 23 affiliated societies, the American Association for the Advancement of Science held its annual convention in the last week of the old year. A representative gathering assembled, and the meetings were successful and profitable in every respect. The presidential address from Prof. Remsen, of John Hopkins University, had special reference to scientific progress and investigation, particular attention being called to the larger benefits, derived by mankind, from chemical development since the days of alchemy. Prof. E. Rutherford lectured on Radium, and illustrated his remarks with interesting and novel experiments. Three papers on the same subject were also read: of the 35 papers presented before the various sections, a third, significantly enough, were on electrical subjects. Prof. W. G. Farlow, Harvard University, was elected president for the ensuing year, and the next meeting will be held at Philadelphia.

◆

The Electrical Conference: Engineering Standards Committee.

We are pleased to learn that the conference convened by the electrical committee of the Engineering Standards Committee, was a thoroughly satisfactory and representative gathering of consulting and manufacturing electricians from all parts of the country. Although the proceedings of the conference are not yet published, we are in a position to say that the discussions which took place with regard to the questions of standard frequencies and motor standardisation have done much towards the settlement of these important matters. The valuable information elicited at the meeting is now under the consideration of the committee, and it may be regarded as a foregone conclusion that the recommendations in course of preparation will be of the greatest benefit to the electrical industries of the Empire.

◆

Travelling Troubles.

The millions who avail themselves daily of electric tube, tram and train are frequently put to serious inconvenience by the failure of some portion of the system, and the subsequent dislocation of traffic. Tube trains are not free from derailment, conduit trams from breakdown, and trolley systems from falling wires. The first two are just tolerated by the public, but the last item strikes a deeper note in that personal danger is attendant upon the occurrence. Various safety devices are now more or less on trial in this country, for the cutting off supply should a wire fall but a few feet, and their continued employment should beget public confidence. Still, incidents of this nature, whether directly effecting the safety of the individual or not, illustrate clearly the lack of perfection in tramway appliances, though, until electric power can be carried on train or car, the travelling public must patiently bear with the systems in vogue.

◆

Electricity in Egypt.

In another part of this issue we direct attention to the opening existing for British electrical engineers in Egypt.

It is surely a reproach to the engineers of this country that the initiation and conduct of electrical undertakings should have been left almost exclusively in the hands of foreign nations. Among the various companies supplying electricity for light and power, and applying it to railway and tram systems, we look almost in vain for the name of a British firm. So far as Egypt is concerned, Cairo and Alexandria are entirely served by companies of Continental origin, and of the numerous lighting schemes in course of realisation in the provinces, only one is being taken up by a British firm—Messrs. Cook & Sons, the well-known tourist agents. From private advices we learn that there are at the present time, in addition to the lighting of towns, public buildings, hotels, and ancient tombs, various other directions in which British electricians might find profitable scope for their energies. Why a land of so much promise should be severely left alone by our countrymen is a matter which fills us with regretful amazement.

❧

Halfpenny Tram Fares.

THERE is no doubt that the adoption of electric traction for our tramway systems has had a great effect in cheapening the cost of travelling to the public, but where these systems are owned by municipal authorities there is a grave danger that this may be carried so far as to threaten seriously the financial stability of their undertakings. The halfpenny fare has in some places been introduced, but while this may be done without serious advantage in one town, it may prove fatal in another. But further than this, the introduction of the halfpenny fare stage is almost certain to lead to trouble in the end, as the populace, which cannot understand the economics of tramways, is sure to demand from time to time an extension of this stage, arguing that the purchasing power of a halfpenny should be half that of a penny, and that therefore the halfpenny stage should be half the length of the penny stage. Of course this argument is untenable. But it is difficult to get the uneducated public to see that. Glasgow has just come through a crisis of this character. The proposal there was to increase the halfpenny stage from one-fourth to one-third of the penny stage, but the Council, after discussion, has wisely rejected the proposal. Glasgow is not yet out of all its difficulties, and it would be folly to run the risk of financial loss which this change would involve.

❧

Marylebone.

THE result of the poll of the ratepayers of Marylebone on the electric lighting question has been announced too late to be included in our note on this subject in the Finance and Legislation section. A majority has been obtained for the proposal to promote the Bill in Parliament, thus reversing the vote at the ratepayers' meeting. The position is therefore now more favourable for the Council, though the difficulties are by no means overcome, and it remains to be seen what the attitude of Parliament will be. Judging by the attendance at the ratepayers' meeting, we thought that the interest of the population of Marylebone was thoroughly roused on this question, and that was to us the most welcome sign of all. It is therefore a disappointment to find that so small a percentage of voters took the trouble to go to the poll. So long as ratepayers take no interest in the conduct of local public business by their representatives, they cannot expect much sympathy when they find themselves placed in unevitable situations by these representatives, and it is of the highest importance that they should realise that their councillors, although trustees, cannot be made personally liable, and that a careful watch should at all times be kept over their financial proposals.

❧

Electro-Steam Locomotives.

ACCORDING to the statements of a Continental contemporary, which may presumably be taken seriously, experiments are being conducted in Switzerland to utilise electricity for raising steam in the locomotives employed on the railway systems of that country. A natural dearth of coal and wealth of water power suggests that the latter be turned to advantage, and as high speeds are neither feasible or desirable any elaborate system of accelerated traction is not needed. The superabundance of water power also would permit of the introduction of a system whose efficiency was below the recognized standard, while any reduction of the initial outlay would be correspondingly welcome. Hence the proposed use of electrically-heated steam locomotives. The old types would require little modification, and beyond the generation and transmission systems little else would be needed. From the scanty details given it is difficult to conjecture what are the commercial possibilities of the scheme, but superficially it should appeal to railway men, as the old staff could readily be trained to the new conditions and either of the standard generating systems, alternating or direct current, could be used. Again, the cost of conversion could be gradually spread over the entire existing rolling stock.

⁂

Mechanical Ventilation of Motors.

Considering the efforts that have been made during recent years to perfect the design of small motors of the enclosed type, such as are used for electric traction, it is somewhat strange that practically no attempt has been made to adopt mechanical ventilation. It is well-known that such machines necessarily run under disadvantageous conditions, for they are small in proportion to the work to be done, and are tightly enclosed. Thus the rise of temperature is proportionately great, and facilities for the dissipation of heat are proportionately small. The general adoption of artificial ventilation for railway and tramway motors is clearly desirable, and as no practical difficulties need be anticipated, the matter is certainly worth the consideration of our readers. In many cases, also, stationary motors are required to work under conditions very little more favourable than those applying to railway motors, and artificial ventilation would be of much practical value. Up to the present, mechanical aid of the kind has only been generally applied to transformers, but there is every reason why the principle should be extended to other electrical machines.

⁂

Electric Traction on the New York Central.

The decision of one of the oldest and most important railways in the United States to convert from steam to electric traction, is one which has aroused profound interest amongst railway engineers and administrators. A recent issue of our contemporary, *The Electrical World and Engineer*, contains an article dealing unofficially with the reasons which led to a decision in favour of the continuous current in preference to the alternating current. The question appears to have been very fully considered before the decision was arrived at to adopt the standard continuous current system. In the first place, as a matter of policy it was thought best to adopt a system which would be in conformity with the various local electric railways in and around the City of New York. This consideration alone might well have carried the day, even if cost and other engineering questions were settled in favour of an alternating system. From the technical point of view an important consideration was, that the various alternating systems which might have been suitable, are all, more or less, in the experimental stage. If an alternating current system were adopted, there would therefore be great probability of considerable alterations and improvements being required from time to time, which would largely add to the cost. Various minor considerations appear to point in the same direction, and, moreover, it was considered that the adoption of the standard continuous current system within the proposed electrical zone would not in any way exclude a resort to an alternating current system for long-distance service when it had been so far developed as to warrant its introduction.

⁂

Electro-Petrol Automobiles.

A promising field for activity is opened up by the recent combination of the electric and petrol systems for driving motor vehicles. Although electric cars are becoming fairly general for use in the metropolis, it is obvious that they are unsuitable for touring purposes. Even with batteries of much greater capacity and relatively less weight than those at present available, the electric automobile must always have a strictly limited range of action, and makers are practically unanimous in believing the petrol car is likely to hold the field for many years to come. The combined system of driving, however, is one specially appealing to our readers, who will find full particulars of the method in reports of the recent Automobile Show at Paris. Combination cars of the kind to which we now refer may be divided into two main classes. In one, the electric system is merely employed in speed transmission from the petrol motor to the driving axle, the engine being direct-coupled to a dynamo which operates an electric motor geared to the axle. In the other class, a storage battery is provided in addition to the petrol engine, dynamo and electric motor. The engine can be operated alone, or used to drive the dynamo which in turn is available for driving the car through the motor, or for charging the battery. When charged, the the battery is available for running the motor, and when steep hills are encountered, the petrol and electric motors can be used together. In one car exhibited at Paris, the dynamo acts as a generator on descending gradients and as a motor to aid the petrol engine in climbing hills. Altogether, the combined system is one possessing remarkable elasticity, and offering considerable scope for the ingenuity of electricians.

❧

On Electro-galvanising.

ELECTRO-GALVANISING, or as it is commonly called, cold galvanising, as distinctive from hot galvanising, has developed into an industry of considerable importance. Almost every large ship building yard in England and on the Continent has an electro-galvanising plant, as the process is extensively used for coating with zinc, boiler tubes, condenser tubes, and the frames and plates for torpedo boat destroyers. The process of electro-galvanising is used for two purposes, firstly, for depositing zinc as a permanent protective coating; secondly, for the purpose of flashing iron work with zinc to give a temporary protection during construction and erection, and also for the purpose of detecting any flaws in the iron or steel before the expense has been incurred of rivetting in the plate or assembling all the parts of a boiler. Great economy and large sums of money have thus been saved. Electro-galvanising is also used for coating very small articles and fittings, which are electro-zinced in revolving barrels so as to ensure a more even distribution of zinc. The difficulties encountered in the original plants—the first of which was erected by Messrs. Laird Bros., at Birkenhead—was the difficulty experienced with the zinc anodes, which caused the composition of the electrolyte to vary considerably, and consequently the nature of the deposit. This difficulty has been overcome by means of a regenerative process which utilises the zinc in a fine state which is placed in filter tanks through which the electrolyte is continually circulated by means of a small centrifugal pump. In our next issue we propose to give particulars and illustrations of some recent up-to-date zincing plants.

❧

Transatlantic Engineering Education.

THERE has been, for some time past, a general feeling that methods adopted in this country for the preliminary preparation of students intending to take up the engineering profession are not so satisfactory as might be desired. In a paper recently read by Dr. Walmsley, at the Institution of Electrical Engineers, we have a statement of the impressions derived by a recent visit to various universities and training colleges in the United States and Canada. From this paper we gather that American pupils who enter technical colleges and schools are far better prepared by their previous training than similar pupils in our own country. Although educational methods in the United States are by no means perfect, it is probably the case that secondary schools are more efficient than our own. This view is confirmed by Dr. Walmsley, who states that boys leaving the secondary schools generally possess a fair knowledge of elementary mathematics, and, as a rule, have acquired the habit of observing and thinking for themselves to a considerable extent. In transatlantic universities and technical colleges far better facilities are provided than in this country, because such institutions have much larger funds at command. It is worthy of note that the total amount contributed by the United States Government for education of university rank reaches the large total of £1,133,600 yearly, apart from contributions from individual States and municipalities. Comparing this figure with the paltry amount of £150,000 similarly provided in this country, we are forced to the conclusion that the importance of higher education is very inadequately recognised by Government. With regard to the future of students who have passed through their college training, the American system is certainly good. Premiums are not required by the employer, who is perfectly willing to take college graduates into his works at a fair remuneration, and, while making all possible use of their knowledge, he takes care to see that they are further trained in a practical and systematic manner. There is no doubt that very considerable improvement has been made in our own means of providing technical education of late years, but much more still remains to be done.

⁂

Blondlot's N Rays. THIS new form of radiation, the discovery of which was recently announced by Blondlot, has formed a powerful focus of interest to physicists during the last few months. Several investigators, having been unsuccessful in repeating his experiments, have not hesitated to say that the origin of the observed phenomena was purely subjective. Such a contention can, however, no longer be maintained in the light of the further detailed results obtained by their distinguished discoverer, and of the abundant confirmation which they have received from the researches of others. The exploration of the extreme ultra-violet end of the spectrum is a very important advance in what we may call purely physical knowledge, but it pales into insignificance in comparison with the interest and importance of the physiological results described in another column. Telepathy and other obscure phenomena are even now regarded with distrust and scarcely concealed aversion by many men of science. A few years ago, the admission that the question of their truth was one for investigation and not for ridicule was sufficient to arouse suspicion as to the perfect sanity of the few physicists who had the courage to take up such a position. The observations of Charpentier and others, that ordinary muscular and nervous actions, and the changes in the brain and spinal chord which accompany conscious and unconscious mental efforts, are capable of exciting electric waves, which can be transmitted through the ether or through wires, and produce purely physical effects upon distant inanimate objects, opens up a wide field for investigation.

Only one more step is required to complete the actual physical demonstration of the possibility of telepathic action, and that is to obtain definite proof of some physical effect of these disturbances upon the brain or other portion of the human or animal organisation. If this further step has not already been made before this was written, it will, in all probability follow very shortly.

⁂

Municipal Credit. IT has often been urged as an argument in favour of municipalities undertaking the ownership and management of trading concerns that these bodies can readily borrow money at a very low rate of interest, thereby enabling them to make a larger profit than is possible when the same businesses are in the hands of companies. With the ratepayers, who, as a class, do not look beneath the surface of things, and who are anxious to find some means of lessening the burden of taxation upon themselves, this argument has had great weight, and in consequence, there has been in recent years a tremendous increase in local indebtedness. Naturally this cannot go on without producing an effect on the money market, and at the present time a reaction has set in, and local authorities no longer find it a simple matter to float loans. Lord Rothschild, whose opinion on financial matters is entitled to great weight, has recently at a public meeting in connection with the London County Council elections, spoken seriously on this subject, and has pointed out that the confidence of the public in municipal credit has been shaken, and will not be restored until a compulsory audit of all local accounts by trained and independent accountants has been introduced. No one who reads without prejudice the evidence taken before the Municipal Trading Committee can fail to realise the necessity for this reform, and we therefore hope that Parliament will at the earliest date pass into law the recommendations of that committee.

Vibration and Nuisance.

SEVERAL cases of nuisance, caused by electricity works, are on record during the month, that of the Isle of Wight Electric Light and Power Co. exciting the most comment. The works of this company are gas driven and adjoin a ladies' school, and presumably the exhaust from the engines, even though this was muffled considerably, proved altogether too annoying. The Bloom Street Works, of the Manchester Corporation, equipped with large vertical compound engines, have occasioned an action for injunction and damages, but pending experiments with the engines, which are now in an advanced stage, a postponement was decided upon. This station, our readers will doubtless remember, is one of the most compact in the Kingdom, for output and class of plant installed. The St. Pancras Borough Council also has had trouble from a similar quarter, the vibration due to some new engines at its combined destructor and electricity works, Camden Town, causing an action for injunction, the operation of which has, however, been suspended for six months. The Great Northern & City Railway has successfully contested a claim arising out of alleged damage to property during the construction of its line; but the Neptune Bank station, Newcastle, is likely to be served with a writ unless a nuisance complained of by the Corporation is abated. Complaints based on trivial matters are usually dealt with as they deserve, but vibration troubles are more serious, especially to the station engineer. When costly experiments, with reciprocating engines are involved, the installation of turbines may present a cheaper solution of the difficulty, while the expenditure might be justified, in that the plant would be quite modern and unlikely to cause further annoyance.

⁂

The Edison Cell.

VERY little was added to our stock of knowledge regarding the Edison cell at the discussion on Mr. Hibbert's paper. Dr. Fleming detailed the results of tests he had made and which, as far as they went, substantially coincided with those already obtained here and abroad; and Mr. Hibbert gave some figures regarding Edison's latest type of cell with two positives to each negative, but this we had also heard about last December from M. Janet. Discussion there was scarcely any—partly, no doubt, because of the long interval which had elapsed since the paper was read, and partly because it was one which hardly lent itself to really relevant discussion. A simple record of tests may be most interesting and valuable, but when it is unaccompanied by any facts or even expression of opinion as to the sources from which spring the novel results, it does not provide any opening for others to offer confirmation or dissent. We have now been thoroughly impressed with what the Edison cell can do, and we next want to know why and how it does it. This is sure to come in due course, but from other sources, for one can hardly expect to find such information in the reports upon the cell of a particular inventor—such knowledge he prefers to keep for his own private use as long as possible. We thought, however, that Mr. Hibbert's comparisons between the Edison and lead cells would be challenged. They certainly did not err on the side of generosity to the latter, nor agree with the claims made by their manufacturers; and a good opportunity was afforded for some definite statements as to what the up-to-date automobile cell can do. But the makers lay low and said nothing.

⁂

Main Line Electric Traction.

WILL electric traction ever be substituted for the steam locomotive on main line railways? This question has been occupying many minds lately, a large number of whom would probably decline to answer in the affirmative. At present, it would be only fair to acknowledge that the benefits of such a conversion do not offer a sufficient inducement for the large capital outlay necessary.

"I may say," observes Mr. James C. Inglis, in a communication on the subject to *The Electrical Magazine*, "that I do not think the time has yet arrived when express trains can be worked on main lines of railway quicker or or economically than under the present method. No doubt the electric system offers advantages in the case of heavy suburban traffic and busy branch lines, but it would not be right to lay down a general law, as the circumstances would differ widely in various cases, and each would have to be dealt with on its merits."

Sir Frederic Harrison, of the London and North Western Railway, adopts a cautious attitude in communicating with us on the same question. "The subject," he says, "is of great interest, and from one point of view or another has of late been frequently discussed in the press and elsewhere. I am afraid, however, I have no information of any scheme in this direction contemplated by the North Western Company, for although they are alive to the possibilities of the new system of locomotion, their attitude so far, has been one of observation, rather than of actual experiment. Naturally they will keep a watchful eye upon all that goes on in the electric world, and in the long run will expect to benefit by the experience and trials of other undertakings or persons."

Mr. Sam Fay, of the Great Central Railway, states that, instead of seeking to displace steam locomotion on their line, they are trying to "find some means to compete with electric tramways by our competing service. It is possible," says Mr. Fay, "that in the near future, a very determined attempt will be made to counteract the effect of tramway competition on railways," and states that he will be pleased to acquaint us with the result at the proper time. From the whole of the communications we have received from the principal railways in the kingdom on the matter, it is very evident that there is little prospect of any movement in the direction of electric traction on our main lines being made at the present time.

As to electrical engineers, they appear to be divided at present between the advocates of single and polyphase systems respectively; but the revival of the pioneer method of producing and transmitting alternate currents of high potential bids fair to oust all rivals from the field if it is given an opportunity of establishing its claims to precedence. Already one firm in this country, the British-Westinghouse, has pinned its faith to single phase currents for main lines, and announce its readiness to equip lines of almost any length on this plan. It is not likely at the same time that any precipitate action in this direction will be entered into.

Electrical Testing and Measuring Instruments.

If one were to make a comparison between the quality of electric testing as conducted by the Telegraph Service and Cable Companies on the one hand, and that conducted by the Electric Supply Companies on the other, it is to be feared that the latter would materially suffer by the comparison. It may be urged that the recording instruments in use in supply stations enable them to make all the determinations as to the actual working conditions of the plant and systems of distribution. However true this may be true, it cannot be denied that the testing department is a very necessary adjunct to a central station; but it must be admitted that such a department is more conspicuous by its absence than by its completeness in many cases. It is not, however, the intention of this note to find fault with the central station engineer, but rather to emphasise the fact that electrical measurements, as in the past, must go hand in hand with electrical development and progress in the future. Continuous and steady progress in matters electrical can best be fostered by persistent experimental and scientific investigation; consequently, it is absolutely necessary in electrical work to have practical experience in definite and exact measurement. It is generally well recognised that the early development of any branch of applied science depends largely upon experimental work, but the experimental determination of the characteristic properties and effects is but the first step in the investigation of any physical phenomenon, for after these have been isolated it becomes necessary to make relative measurements and to compare the magnitudes of the quantities discovered experimentally. We are now assured that nothing occurs in the physical world but what is in accordance with natural law, and the relationship expressed in terms of a law are the foundations upon which applied science is developed. It is equally true, to-day, that applied electrical work is pre-eminently quantitive; and, just as the marvellous developments of electrical engineering have, in the past, resulted from the untiring endeavours of a noble army of scientific investigators, so future achievement depends upon persistent research conducted with care, precision and attention to minutest detail. The determination of constants and coefficients, the question and reliability of standards of reference, and the permanancy and stability of the materials employed in the various departments of electrical work all afford opportunities for scientific investigation and research. Experimental work and electrical measurements may be divided into several distinct branches of work :—(1) improvements in electrical measuring instruments and appliances ; (2) the determination of constants and the standardization of appliances, and (3) observation of new phenomena and the verification of new theories and processes. It, therefore, appears reasonable that *The Electrical Magazine* should devote some space to encourage electrical testing, and to form a complete record of new methods of electrical measurements and testing, and to announce and describe the principles and construction of electrical measuring instruments. All such questions as affect the well being of the scientific and commercial life of electrical engineering will be fostered to the fullest extent in this important section.

The Coming of the Steam Turbine.

FROM all quarters come signs that the reciprocating engine is doomed for such special work as the driving of dynamos and the propulsion of ships. With the latter we have nothing to do. It is the springing into prominence of the steam turbine as an aid to the cheap and efficient production of electrical energy with which we are chiefly concerned. The growing interest evinced in the development of this time-honoured prime mover on so large a scale is a striking testimony to the accuracy of modern constructional methods, while indicating the strong desire of engineers for improvement on designs now obviously outgrown. The return to high speeds with turbo-dynamo machines is significant of the increasing difficulty in building, and especially in maintaining, reciprocating units which shall be compact and yet require a minimum of attention and repair. The important papers on the subject of steam turbines laid before various institutions lately, and the confident utterances of Mr. George Westinghouse on the subject, at the annual meeting of the shareholders of the British company bearing his name, are encouraging signs of the determination of engineers to "see this thing through." The combination of American and German interests in the Curtis and Reidler-Stumpf designs respectively, further strengthens the conviction that this revival of an old principle on modern lines can have but one climax—and that at no distant date—the complete supercession of the steam reciprocating engine. That this is no idle boast, the continued installation of such machines in large sizes undeniably signifies, while the additional evidence afforded by the action of some of the oldest builders of reciprocating engines in undertaking turbine construction, furnishes the balance of proof were such needed. As our readers are aware, several power schemes and stations at present constructing to supply railways are installing huge turbine units, and the latest addition to the list is no less a body than the Glasgow Corporation, who conclude that both, on grounds of capital cost and steam economy, steam turbines are desirable for the extensions at both their lighting stations. Two 3,000 K.W. units, by Willans, Dick Kerr, will be installed at Port Dundas, and one 1,400 K.W. set by the same turbine makers, but with Siemens generators at Pollokshaws Road.

The small space occupied by turbines, especially the vertical type, raises an important question in the lay-out of a power station fitted with such machines. Demands on the boiler house plant are in no way minimised, but this portion of the station equipment has undergone no change in point of size, at any rate not in anything like the same degree as is noticeable with the engines. Obviously if the floor space saved by the smaller unit is not embraced by a corresponding re-adjustment of the boiler house plant, the advantage of the turbine as a ground economiser will be discounted.

We shall give in our next issue plans of a typical station employing Curtis turbines, and the point here raised will then be more fully exemplified. For the present we are convinced that the turbine will raise the level of steam driven stations in this country to that sphere of economy now occupied by water power plants operating in America and on the Continent.

Mining and Electricity.

The series of articles on electricity in mining and metallurgy commencing in this issue synchronizes well with the publication of the Departmental Committee's report on the use of electricity in mines. Winding engines form the chief subject touched upon this month, and English engineers and colliery managers will do well to study the examples of German plant which are illustrated and described. Hitherto, steam has held supreme sway for winding purposes and electricity though welcomed for the lighter duties of hauling, coal cutting and operating auxiliary plant has not been permitted to enter a domain regarded as exclusively reserved for steam by colliery men, at any rate, those in this country. The fluctuating demands for power, the necessity for complete control over the engine and the need of simplicity and economy in working, are factors which have retained the field for the steam engine and excluded the electric plant on grounds of both prejudice and precedent. In spite of our natural wealth of coal we have been slow as a nation to employ modern methods of coal getting, and doubtless the same reluctance which has marked our actions in introducing electricity for the minor operations mentioned above, will be noticeable before the supercession of the steam by the electric winding engine becomes an accomplished fact. The two cases, are, we fully realize, hardly parallel, as the adoption of electricity for operations obviously of a temporary nature could not fail to impress its advantages on colliery proprietors; consequently electrically driven coal cutters, drills, pumps and hauling engines are now on the increase. With the winding engine, however, the subject must be approached differently, as mere economy is not always reckoned, and, moreover, the average steam winding plant does not throw much away. English engineers have not built steam machinery for years without knowing what depreciation means, and naturally they cast one eye on the results attributed to the electric winding engine while the other is taking in the details—and they are by no means few—of the machine which is vaunted as a powerful rival to their beloved steam plant. We hold no brief for steam engineers, but from the position of affairs, greater persuasion will be needed to introduce the electric winding engine than was necessary with electrically driven auxiliary plant. Our esteemed contemporary, *The Colliery Guardian*, has recently admitted into its correspondence columns several valuable contributions on the subject from both sides, and strong indications of confidence in the old plant are everywhere noticeable when the winding engine problem is touched upon. One advocate of steam remarks: "If the energy in the steam is first to be put through an engine and dynamo, turned into electrical energy, and then transmitted to the motor of the winder, instead of transmitting the steam direct to the winding engine, where is the saving to come in?" This, to our mind, sums up the attitude of the colliery engineer. He wants something simple, and while he has that in his steam plant he will not lightly discard it. But, and here lies the hope of the electrician, electrical energy is now widely employed for auxiliary purposes in collieries, and nothing could be more rational than to utilise it also for the winding engines. To generate electricity for the latter alone is one thing, and unlikely to be countenanced; but to apply it generally throughout the whole operations of the colliery is another, and to our thinking the most sensible way out of the difficulty.

We shall certainly look for development on these lines, as colliery plant is too closely watched to admit of reckless extravagance in operation, and when the opportunity we have indicated is ripe, the management will not, in our opinion, be slow to embrace it. The same shrewdness which prompted the introduction of electricity for auxiliary operations will be equally evident when conditions are favourable for its expression on a wider scale to winding plant.

IT IS A PATENT FACT in the history of journalism, that the value of first numbers of epoch-making publications becomes enormously enhanced as time goes on.

HAVE YOU SECURED your copy of No. I of *The ELECTRICAL MAGAZINE?* It is the key-note to all succeeding issues, and without it all future numbers will be incomplete. The second edition of this unique first issue is now almost exhausted, and repeat orders are daily reducing the limited number left. It is bound to go to a high premium, and it will, therefore, be necessary, if you have not obtained a copy and desire to secure one whilst the opportunity lasts, that you should send for same without delay, to our Publishing Offices, 4 Southampton Row, Holborn, London, W.C.

N.B.—If you become an annual subscriber you will be sure of getting every issue without trouble.

READERS are referred to a note at foot of page 224 in regard to the figures which appeared in our leading article in last issue.—[ED.]

SPECIAL ARTICLES

The articles under this section being of general interest to electrical men, are not classified under the ordinary sections of the magazine.

THE THEORY OF ALTERNATORS.—II.

By ALFRED HAY, *D.Sc., M.I.E.E., etc.*

(Continued from page 30).

It will be convenient to apply certain terms to the various magnetic fluxes (α), (β), (γ), (δ) and (ϵ), and these we now proceed to define.

Consider an alternator which is either at rest, or else running on open circuit. The assemblage of all the lines or tubes of magnetic induction, due to the field ampere-turns, we shall call the *open-circuit field*. It corresponds to the flux (δ), and is in general a purely imaginary flux when the alternator is loaded: for in that case the armature ampere-turns produce a magnetic effect, which is superposed on that due to the field ampere-turns. Of the total number of lines constituting the open-circuit field, a certain proportion will enter the armature core, forming the *impressed armature field*, while the remainder will follow paths not intersecting the armature core, and will form the *primary leakage field*, which corresponds to (β). The ratio $\frac{\text{open-circuit field}}{\text{impressed armature field}}$ is known as the (Hopkinson) *leakage coefficient* for the field-magnet. The value of the leakage coefficient will increase to some extent with increasing exciting current, although this increase is hardly appreciable so long as the permeability remains approximately constant. As the iron gets saturated, the leakage coefficient approaches a certain limiting value, corresponding to the constant value which would be obtained if the iron of the field and armature were replaced by some non-magnetic material.

If the alternator is running on open circuit, the impressed armature field will generate in the armature winding a certain E.M.F., which we shall call the *open-circuit E.M.F.* of the alternator. As soon as the armature is allowed to give a current, this current will produce an alternating field—the *fictitious armature field*—which will be superposed on the open-circuit field, modifying it more or less. On the assumption that the varying fictitious armature field obeys the simple harmonic law, we may take the maximum value * of the field in considering its magnitude. As the name itself indicates, this field has no independent existence; it corresponds to the flux (ϵ), and is merely one component of the actually existing field. Some of the lines or tubes forming this field will pass through the field cores, and will become superposed on the lines of the open-circuit field, while the remainder will become linked with the armature winding without undergoing any linkage with the field winding; this set of lines forms the *secondary or armature leakage field*, and corresponds to the flux (γ). Finally, the resultant field common to both armature and field cores, and due to the superposition of the fictitious armature field on the open-circuit field, gives us the *main field*, and corresponds to the flux (a).

---

* In point of time.

To sum up, then, we have three actually existing fields, namely: the *main field*, the *primary leakage field*, and the *secondary leakage field*; and two purely hypothetical fields, the *open-circuit* and the *fictitious armature field*, whose superposition gives rise to the three actually existing fields.

It may be well to emphasize the fact that all the actually existing fields are varying fields, and that in considering their magnitudes we take their maximum values.

Corresponding to the four magnetic fields associated with the armature, we have four armature E.M.F.s, two having an actual existence, and two being purely hypothetical. We have already considered the hypothetical E.M.F. corresponding to the impressed armature field, and known as the *open-circuit E.M.F.* Superposed on this is another hypothetical E.M.F., due to the fictitious armature field, and which we shall call the *self-inductance E.M.F.* The result of the superposition gives rise to two actually existing armature E.M.F.s, namely: that due to the main field, and forming the *main armature E.M.F.*, and that due to the armature or secondary leakage field, and forming the *leakage self-inductance E.M.F.*, or *leakage E.M.F.* simply.

Considering next the primary or field circuit, we see that in this circuit there are also four E.M.F.s, two being real and two imaginary. In the case of an alternator of the usual type, whose field winding is supplied at a constant P.D., the hypothetical E.M.F. due to variations in the open-circuit field vanishes, since this field is a steady one. The other fictitious E.M.F., however, corresponding to the fictitious armature flux, does not entirely vanish; it is true that the fictitious field which produces it is a varying one, and is during its variations carried round relatively to the field winding, in such a manner that the effect of the time-rate variation is to a large extent neutralised by the space-rate of change of position, yet the two actions do not completely neutralise each other. Of the two really existing E.M.F.s in the field circuit, one is brought about by fluctuations in the main field, the other by fluctuations in the primary leakage field. It follows from this that in a loaded alternator the exciting current, even if derived from a source of constant E.M.F., will be subject to fluctuations brought about by the alternating E.M.F.s induced in the field winding. The existence of such fluctuations has been known for a long time. It may, however, be mentioned that in most cases their amplitude is very small in comparison with the mean value of the exciting current, and that they are powerfully damped by the eddy-currents induced either in the solid portions of the field-cores, or, in some alternators, in the "damping coils" specially provided for this purpose.

IDEAL SIMPLE ALTERNATOR.

The meaning of the various terms just defined, and their importance in determining the regulation of an alternator, will best be understood by studying an ideal case—that of an alternator whose field-magnet consists simply of a long solenoid without any iron core, and whose armature is in the form of a simple coil of wire rotating inside the solenoid, about an axis which is perpendicular to the axis of the solenoid, and passes through its middle point.

It might at first sight seem as if the behaviour of so simple a machine had no relation whatever to that of an actual alternator. As a matter of fact, however, in studying the action of such an ideal alternator, we shall be studying the earlier imperfect theories, which are based on assumptions as simple as those realised in the case of our ideal machine. It is, therefore, not surprising to find that when such theories are applied to actual alternators, they frequently fail to give a satisfactory account of what is actually found to take place.

On the other hand, the value of a theory developed for such an ideal case must not be under-rated. It does give us a broad general account of the main features of the problem. As a working theory for obtaining *quantitative* results, or for purposes of design, it may be a dismal failure; but as a means of enabling one to form a more or less *qualitatively* correct mental picture of the actions involved, it is an immense help, and forms the most fitting introduction to the study of this complicated subject.

In order to obtain still further simplification, we shall, in the first instance, make the assumption that the feeble E.M.F.s induced in the field winding (the solenoid) are so small as to cause nothing beyond imperceptible ripples in the exciting current. Even if the alternating E.M.F.s induced in the solenoid were appreciable, their effect in producing ripples in the exciting current could be suppressed to any desired extent by connecting in series with the solenoid a sufficiently large reactance.

The regulation of our simple alternator—that is, the difference between the terminal P.D. on open circuit and at full load current—depends, as will be shown in the subsequent investigation, on the phase relations of the current and the open-circuit E.M.F. In order to obtain sufficient generality, we shall therefore suppose the load to be such that with the given frequency, the current lags 45° behind the open-circuit E.M.F. Otherwise this may be expressed by saying that the maximum value of the current occurs when the plane of the coil makes an angle of 45° with the axis of the solenoid, and is receding from it, and that the zero value of the current occurs when the plane of the coil is at an angle of 45° to the axis, and is moving towards it.

The coil (or armature) being supposed to revolve with uniform angular velocity, p, the open circuit E.M.F. may be represented by $e = E \sin pt$. We shall suppose the external circuit to be surrounded by a medium of constant permeability, so that the current due to the impressed or open-circuit E.M.F. will also be a sine function of the time. If r, R; l, L stand for the resistances and inductances (or "self-inductions," to use an older term), of the armature and the external circuit respecttively, then the current i is given by $i = I \sin (pt - \theta)$, where $I = E / \sqrt{(r + R)^2 + p^2 (l + L)^2}$, and $\tan \theta = p (l + L) / (r + R) = \tan 45° = 1$. It is to be particularly noted that the term "armature inductance" (or self-induction), is here used in its proper and legitimate sense, to denote the total linkage of magnetic flux * with the various turns of the armature (*i.e*, the sum of the magnetic fluxes threaded through the various turns), when there is a unit current flowing through the armature, and when all other magnetic fields (including that of the solenoid) in the neighbourhood of the armature are wiped out. This remark is made here because by some writers the term "self-induction," as applied to an alternator armature, is used in a totally different sense, which will be explained at a later stage.

(To be continued).

Alfred Hay

This series of articles will be continued next month by Professor Hay, who will then deal with the disturbances taking place in a variable magnetic field, his argument being illustrated by a number of valuable diagrams. Those who have followed the problem in the first and second articles should not fail to read the next instalment.

---

* When using the practical units (volt, ampere, ohm, henry, etc.), the magnetic flux must be expressed in *webers*. One weber=10^8 C.G.S. units.

ELECTRICITY APPLIED TO MINING AND METALLURGY.

I. Winding and Hauling Engines.

By PERCY R. ALLEN, A.M.I.C.E.

IN the following series of short articles an attempt will be made to describe what is now being done on the Continent in the way of applying electricity in mining operations and in iron and steel works. Of course, much is also being done in the same direction, both in England and America, but up to the present time most progress has been made in Westphalia and Silesia. The Industrial Exhibition held at Dusseldorf during the summer of 1902 showed very clearly with what confidence electric transmission had come to be regarded by German engineers and mine managers. It was generally, though vaguely, recognised that electric power could be transmitted and utilised down a coal mine, but it was somewhat of a revelation to find that the *whole* operations of a deep mine, from the working of the main winding engines and the underground hauling engines, to the mine pumps, ventilators, and rock drills, could be safely and economically carried on by electric motors, supplied with energy from a central station at the pit's mouth.

The problem of using electric motors for the main winding engine has brought forth several alternative systems. One arrangement of these was shown at the Dusseldorf Exhibition, and was the result of the joint co-operation of Messrs. Siemens & Halske, of Berlin, and the Aktiengesellschaft Bergwerksverein Friedrich Wilhelmshutte in Mulheim a. d. Ruhr, and it was intended at the close of the exhibition to erect this machine at the Zollern II. Pit of the Gelsenkirchener Bergwerks-Aktiengesellschaft. The machine, when working at its maximum capacity, is designed to raise a load of about four tons of coal in one lift from a depth of 547 yards, at a speed of 65 ft. per second. Taking 16 effective hoisting hours per day, this amounts to a daily winding capacity of 2,700 tons, with a single unloading platform. With a double platform the capacity increases to 3,200 tons, and with three platforms to 4,000 tons.

The external appearance of the machine is clearly shown by Fig. 1, while Fig. 2 explains diagrammatically the electrical connections. In this system the two cages are attached to an endless rope which at the top passes half way round, and fits into, an oak lined sheath on the circumference of a Koepe drum 20ft. in diameter. On each side of the winding drum is a 500 volt continuous current motor of 1,400 h.p. By combining a storage battery with the supply system, and arranging the motors for series parallel control with variable excitation of the field magnets, seven working speeds are available, viz., 6·5, 13, 16·5, 19·5, 27-32, 39, 52-65 feet per second, and a special speed for the examination of the rope. The storage battery is divided into four groups, and the switching arrangement is such that each set of cells does as nearly as possible equal work. The starting gears shown in diagram by Fig. 3 are perfectly separate for each motor, but either arrangement can be connected to either motor, and if one breaks down the other motor takes up the load. The work can also be continued if the battery is cut out. The controlling gear is shown on the right hand side of Fig. 1, and the several movements are actuated by a compressed air cylinder combined with a dash pot, the various switching and reversing movements following the direction of a controlling lever somewhat in the manner of a steam steering gear. Powerful automatic brakes, worked by compressed air, act directly on the opposite sides of the drum. Baumann's safety device and cage indicator is also provided, the latter showing at any moment on the vertical column the exact relative position of the cages in the pit shaft, bringing into play, at the same time, various safety devices as the cage approaches the bank. Altogether this was a most interesting machine, the special features consisting in the use of direct current from any 500 volt circuit, and of two motors with series parallel control, combined with what the makers call the "buffer" storage battery.

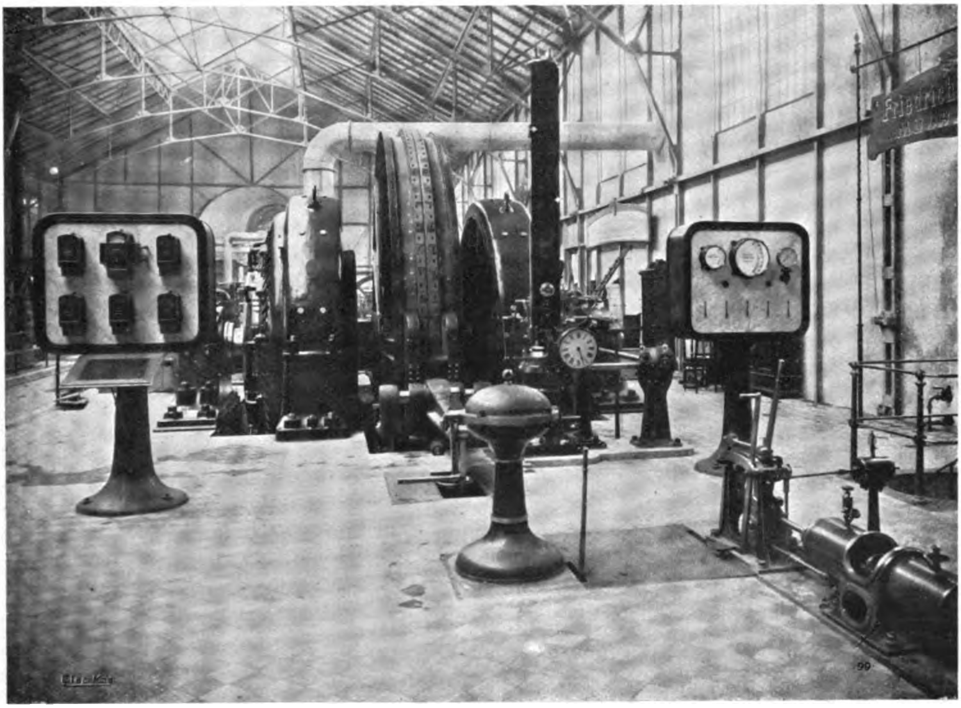


FIG. 1. 2,800 H.P. ELECTRIC WINDING ENGINE.

Another electric winding engine which is identified with the name of Siemens is that known on the Continent as the Ilgner-Siemens, jointly worked out by Mr. Carl Ilgner, of the Donnersmarckhutte, O.S., and the Siemens & Halske A.G. In this arrangement no accumulators or rheostatic resistances in the motor circuit are employed. The original source of supply may be continuous, single phase, or three phase current; and, whichever it may be, it is led to what the makers term a "flywheel convertor." Fig. 4 shows a diagram of the general arrangement. The continuous current generator of the flywheel convertor supplies a continuous current motor driving the winding drums or a Koepe pulley, the two armatures being directly connected without the interposition of any switches or fuses. An exciter shown on the left hand side of the flywheel convertor furnishes current for the fields of the continuous current generator on the convertor, and also on the motor of the winding engine. This exciting current is controlled directly by the position of a regulating lever, actuating suitable resistances. If this regulating lever is put over to the "off" position while the winding motor is running at full speed, the latter gives back current to the generator, thus utilising for braking purposes the energy in the moving parts of the flywheel by acceleration of the same. This is an important feature of the system, in that the very heavy flywheel on the convertor acts as the equivalent of an accumulator, and protects the power station from the effects of load fluctuations. In fact, sufficient energy is stored up by the flywheel to enable the cage to complete its journey, if from any cause, the main supply of current should fail. The ordinary brakes are arranged like those on a steam winding engine, except that they are actuated by compressed air, but an independent and additional safety brake is provided, which is controlled from the depth indicator in a very ingenious manner. Reference to Fig. 5 will make it clear that the interlocking is so arranged that it is impossible for the driver to be flurried into making a mistake. One advantage of the Ilgner-Siemens system is that it can be readily connected to existing steam winding engines, the winding motor being simply placed on a line with the shaft, and connected to it by a drag link. To meet special requirements it has been proposed in some instances to mount the motors and winding drums directly on the structure of the pit head gear itself.

Messrs. Siemens give the cost of an electric winding installation, including winding drums, flywheel convertor, controlling apparatus, head gear, and all cables to power station as between £7,500 to £8,000. This apparatus would wind 2½ tons of coal at 40 ft. per second from a depth of 1,650 ft. Concerning the working cost, it has been proved that the actual running of an electric winding engine dealing with 300,000 tons per year with coal at 10s. per ton delivered to the boilers, amounted to a saving of something like £2,000 per year, compared with an ordinary arrangement of steam plant.

A further adaptation of the Ilgner system is illustrated in Fig. 6, which shows an electrically driven winding engine built by the Breitfeld-Danek Engineering Company, of Prague, for Fortschrittschacht-Brûx, Bohemia. There are two winding drums, each 8ft. 6in. in diameter, one of these being keyed direct to the main shaft, and the other adjustable by means of a toothed ring. The engine will wind from a depth of 323 yards with a single layer of steel rope, at a maximum speed of 787·2 feet per minute, and will lift a gross load of 3 tons 16 cwt., corresponding to a net load of 19·2 cwt. The engine is driven by a direct current motor of 80 B.H.P. through single gearing, 1 to 6, a steel wheel and bronze pinion with planed teeth being used. Besides the brakes shown on the side of the drums, there is a separate brake on the motor axle. The winding indicator moves back the regulating resistance towards the end of the wind, and should it tend to overwind, puts both brakes on.

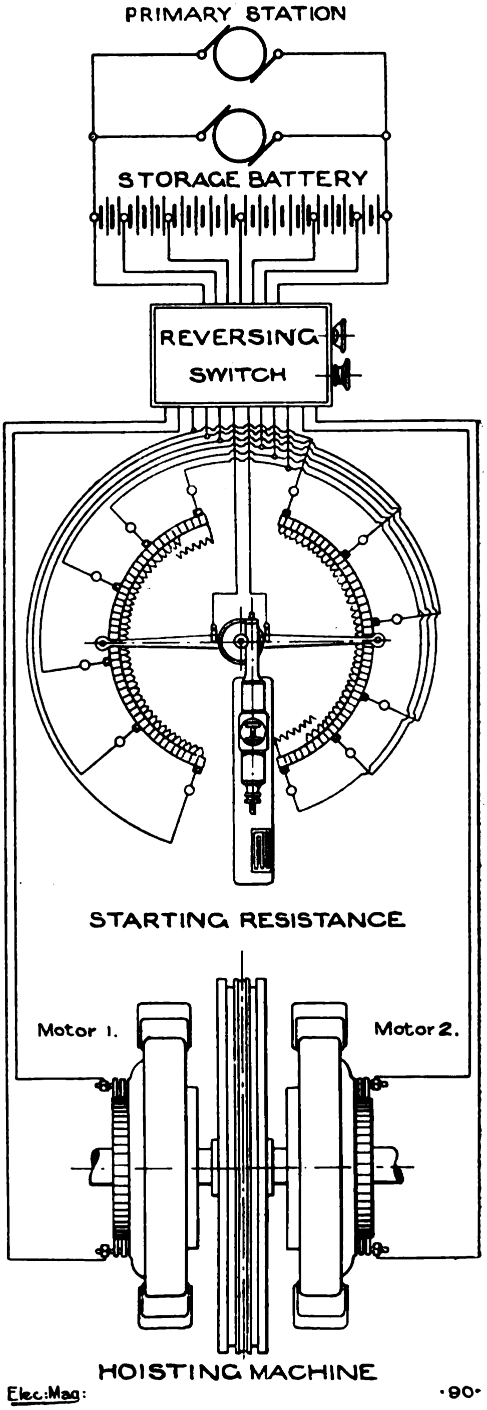
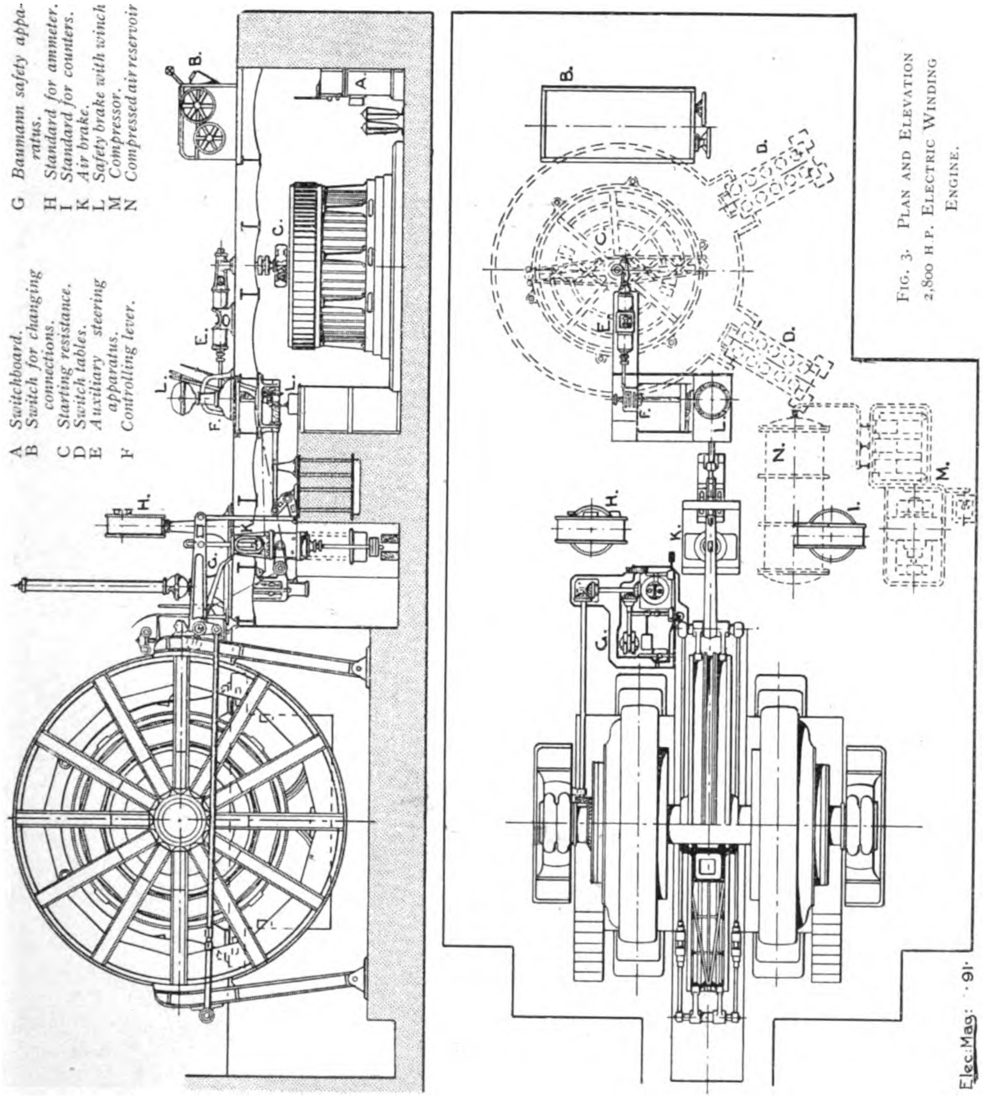


FIG. 2. DIAGRAM OF CONNECTIONS, 2,800 H.P. ELECTRIC WINDING ENGINE.



A	*Switchboard.*
B	*Switch for changing connections.*
C	*Starting resistance.*
D	*Switch tables.*
E	*Auxiliary steering apparatus.*
F	*Controlling lever.*
G	*Baumann safety apparatus.*
H	*Standard for ammeter.*
I	*Standard for counters.*
K	*Air brake.*
L	*Safety brake with winch*
M	*Compressor.*
N	*Compressed air reservoir*

FIG. 3. PLAN AND ELEVATION 2,800 H.P. ELECTRIC WINDING ENGINE.

The small centrifugal governor shown at the base of the indicator puts the brake on if from any cause the speed should get too high during the winding. The illustrations give a very good idea of the great compactness of an electric winding engine.

In both the arrangements of winding engines just described, the power is actually transmitted to the winding drums by continuous current motors, although in the Ilgner system the primary source of current may be three-phase, the actual lifting is done by continuous current. However, in the following systems, three-phase current pure and simple is used to drive the motors. A very interesting installation of the kind has been erected at the Germania Colliery, Westphalia, by the Helios Electrical Co., Ltd., of Cologne-Ehrenfeld. A general view of this is shown in Fig. 7. The motor is in this case of the asynchronous multipolar induction type, with twelve poles, and may be clearly seen in the illustration in front of the large double helical spur wheel between the drums. The normal output of the motor is 120 B.H.P., at 485 r.p.m., but the makers say

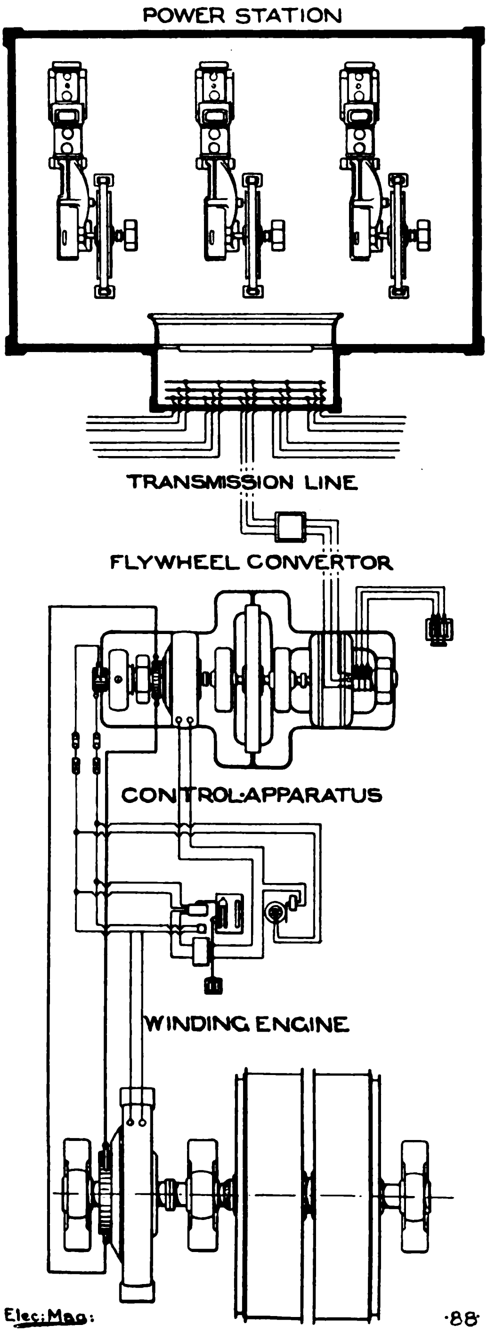


FIG. 4. DIAGRAM OF CONNECTIONS, ILGNER-SIEMENS ELECTRIC WINDING SYSTEM.

that the overload may be increased 100 per cent. for a short time. The winding drums, each 11 ft. 8½ in. in diameter, revolve through double reduction gearing at 16 r.p.m., and wind from a depth of 1500 ft. at a speed of nearly 10 ft. per second with a normal load of 1¾ tons, which may be increased when lowering to 3½ tons. At the beginning of the hoist about 200 B.H.P. is required, but as soon as the cage has reached its normal speed this decreases to 40 B.H.P.

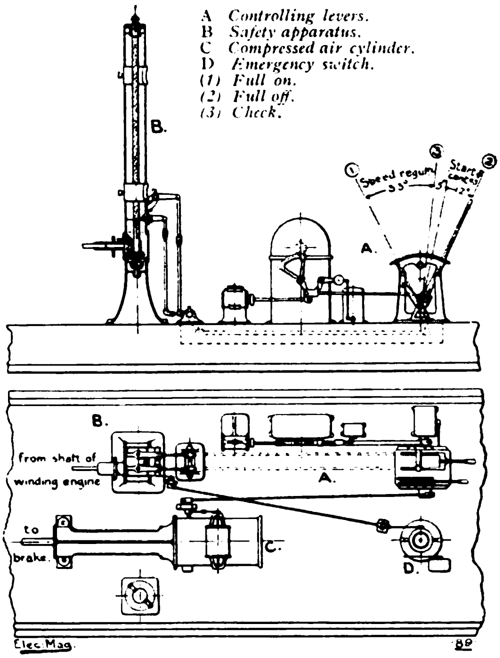


FIG. 5. CONTROLLING APPARATUS, ILGNER-SIEMENS WINDING SYSTEM.

All conductors carrying high tension current are embedded in the slots in the stator and carefully insulated. The voltage of the rotor circuits is 500, there being three slip rings provided with star connections. When starting, resistances are inserted in each phase connection, and as soon as the motor reaches full speed it may be short circuited. The reversing of the motor is effected in quite a simple way, *viz.*, by reversing the connections of two phases at the stator terminals. All the operations of starting, regulating the speed, lifting the brushes, short-circuiting the armature, and reversing the motor are carried out by a combined switch fitted with one handle only, *i.e.*, the reversing controller. The handle being in the "off" position two phases are switched off and all resistances

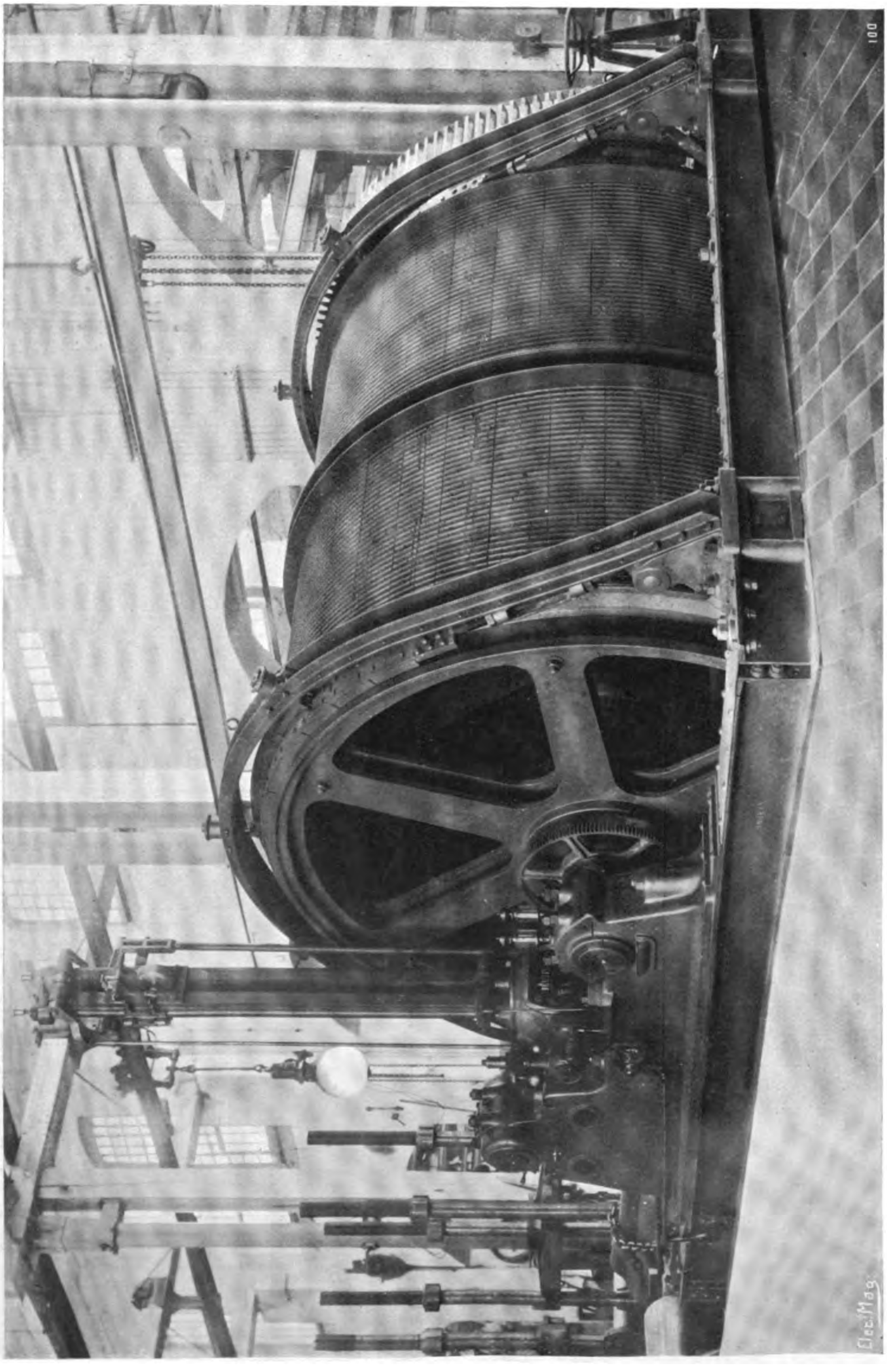


Fig. 6. Electric Winding Engine of 80 b.h.p.

inserted; reaching the next step all phases are switched in, thereby inducing current in the rotor circuit, this current being very small, as all resistances are still in circuit. Turning the handle further, the resistances (connected in series) are gradually cut out, and finally the brushes are lifted and the armature short-circuited. There is a strong spring catch in the "off" position, and a notched wheel enables the attendant to feel on each step when the controller fingers are in complete contact. The handle acts in sympathy with the turning motion of the drums, as seen from the attendant's stand.

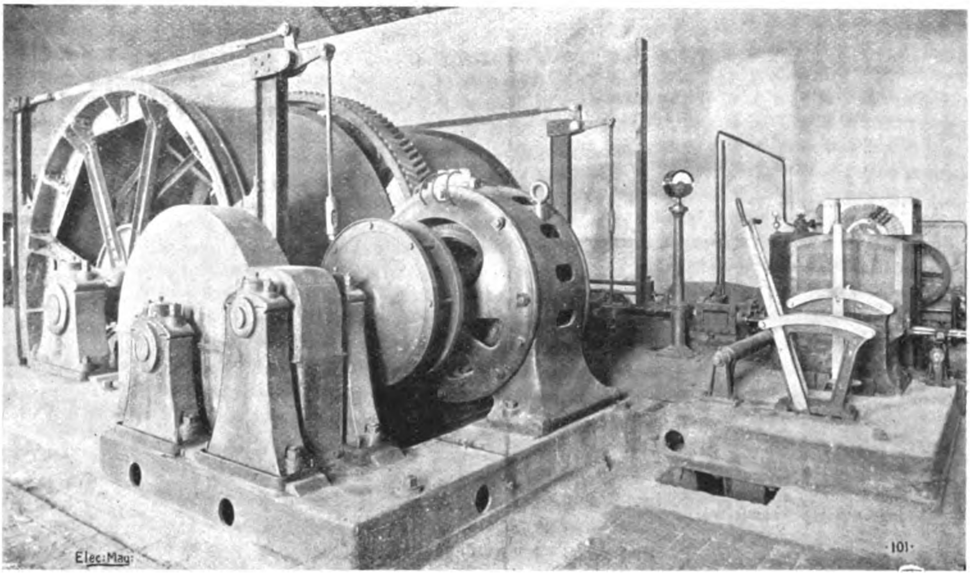


FIG. 7. 120 BRAKE H.P. ALTERNATE CURRENT ELECTRIC WINDING ENGINE.

Two separate brakes are actuated by a compressed air cylinder working at a pressure of six atmospheres, and having an oil dash pot control. In case of emergency, the brake can be applied by a falling weight. The whole of the safety arrangements appear to be worked out in a very complete manner. As soon as the speed of the motor exceeds synchronism, it commences to work as a generator, checking any further speed increase, and thus becomes self-regulating.

The hoisting plant is 2,398 yards from the power station, where there are two horizontal compound engines, each giving 375 B.H.P. at 125 r.p.m., the three phase generators, each of 300 K.W. output, being coupled direct to the crank shafts. The Helios Co. state that the plant has been working successfully for upwards of two years without any repairs or renewals, and give figures to prove that the total efficiency of the electrical combination is 60 %. Taking coal at 10 marks per ton their calculations show that this results in a saving of £430 in the fuel bill, and that there may be still further saving up to £500 per year in labour and attendance on the boiler plant, which in this case is all concentrated at the central station. It is, of course, easy to realise that an electrical winding engine may have considerable advantages over a steam engine in the way of smooth running, stopping and starting, and in some respects, safety of operation, but one would hardly expect that, with coal at the door, it would be more economical to operate than a steam engine. However, the makers of all these electric winding engines are all firms of eminence, and the experience they have obtained appears conclusive.

The well-known Allgemeine Elektricitats Gesellschaft, of Berlin, is another German firm who have laid themselves out for the complete equipment of collieries, and they also build electric winding engines with

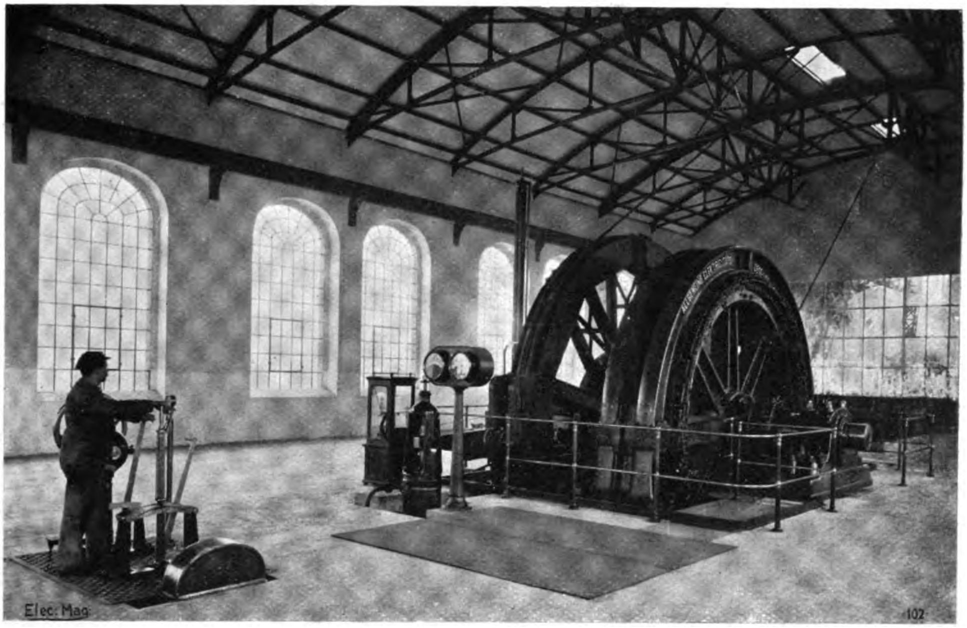


FIG. 8. HIGH VOLTAGE ELECTRIC WINDING ENGINE.

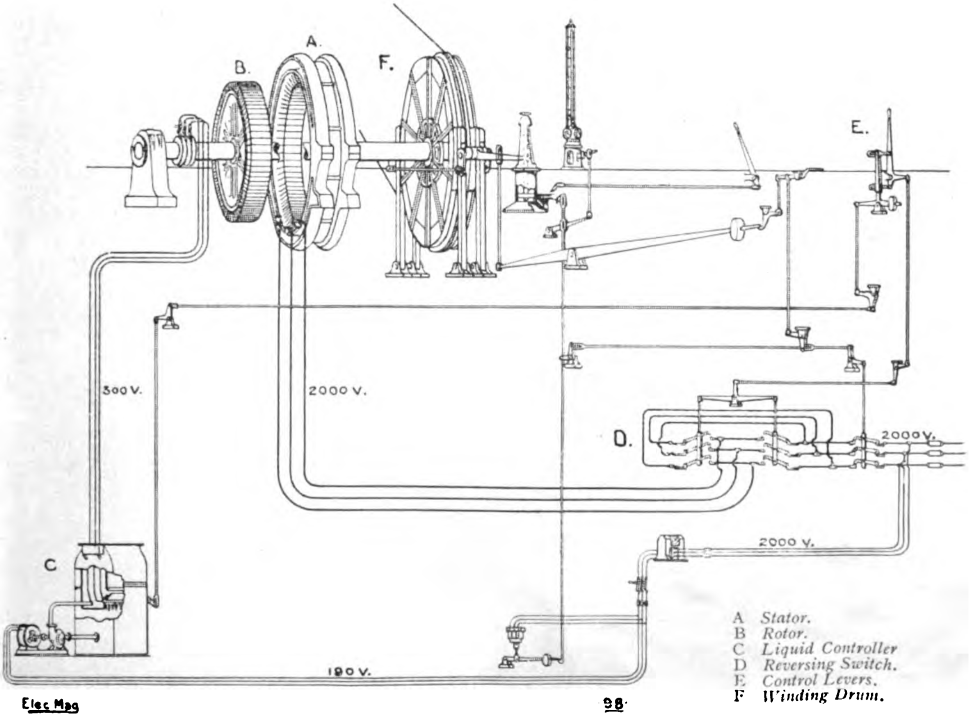


FIG. 9. DIAGRAM OF CONNECTIONS, HIGH VOLTAGE ELECTRIC WINDING ENGINE.

three phase motors applied direct to the axle of the winding drum. Fig. 8 illustrates a large plant erected at the Preussen II. Pit of the Harpener Mining Co., of Dortmund. This will lift 100 tons of coal per hour from a depth of 766 yds. at a speed of 52 ft. 6 in. per second, the winding drum of the pulley being 19 ft. 8 in. diameter. Current is supplied to the stator windings at 2,000 volts, and passes through high tension fuses and safety cut outs before reaching the main cut-out, and change-over switch, current, or cuts it out altogether, and within the determined limits varies the speed of the rotor and winding drum. Four brake blocks act on the side of the drum, and these under ordinary conditions are worked by a compressed air cylinder with a valve lever near the controller. An emergency brake, worked by a falling weight, comes into operation should the current be interrupted, and at the same time the safety cut outs are also opened. The safety brake may be operated by the foot of the driver, or by an automatic electro-magnet. The the latter operated by a controller lever on the driver's platform. The three phases of the rotor winding are connected to electrodes in a tank containing a solution of soda which is caused to circulate by a small motor driven centrifugal pump, and this circulation is controlled by a valve actuated from the main controller lever. As the liquid rises up the electrodes, the speed of the motor increases, and the regulating mechanism is so arranged that it directly follows the motion of the control lever, which reverses the direction of the stator and switch frames and rods are earthed. All the high tension parts are kept below the floor, and cannot be inspected until current has been cut off. The general arrangement of the electrical connections is shown by Fig. 9.

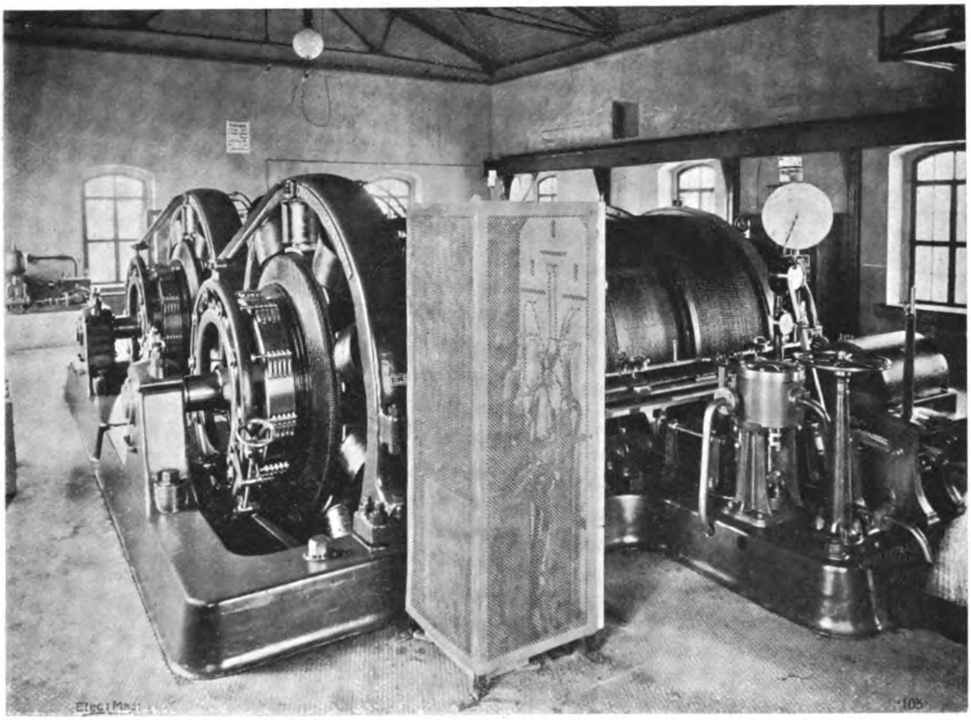


Fig. 10. Continuous Current 500 Volt Electric Winding Engine.

In the generating station at the Preussen Pit II., three-phase dynamos, each having an output of 550 K.W. and a frequency of 50 periods, are driven by horizontal cross connected compound engines at 94 r.p.m. and supply power to the winding engine, mine pumps, and general service of the mine.

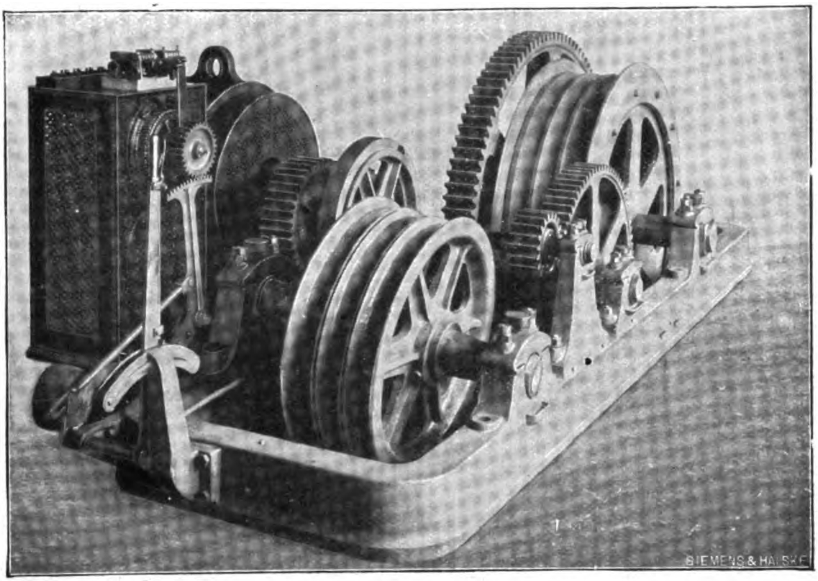


FIG. 11. POLYPHASE ELECTRIC HAULING PLANT.

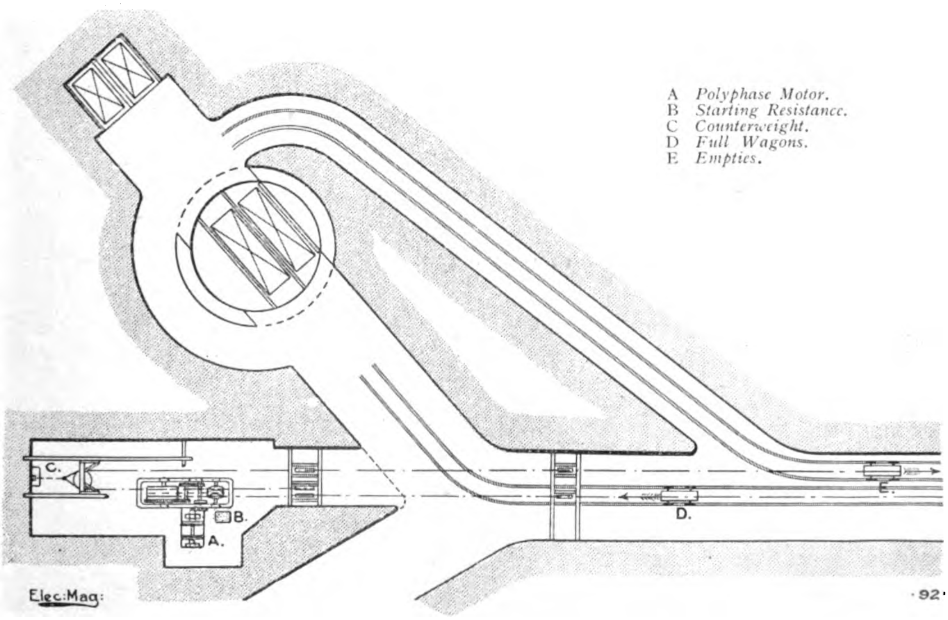


FIG. 12. PLAN OF WORKINGS, SHOWING APPLICATION OF ELECTRIC HAULING ENGINE.

The A.E.G. have carried out a large number of electrical mine equipments on the Continent, mostly three-phase, but at the Arnim colleries, near Zwickau, in Saxony, they have installed a very interesting example of electric winding engine worked by continuous current motors. In this case a continuous current motor on

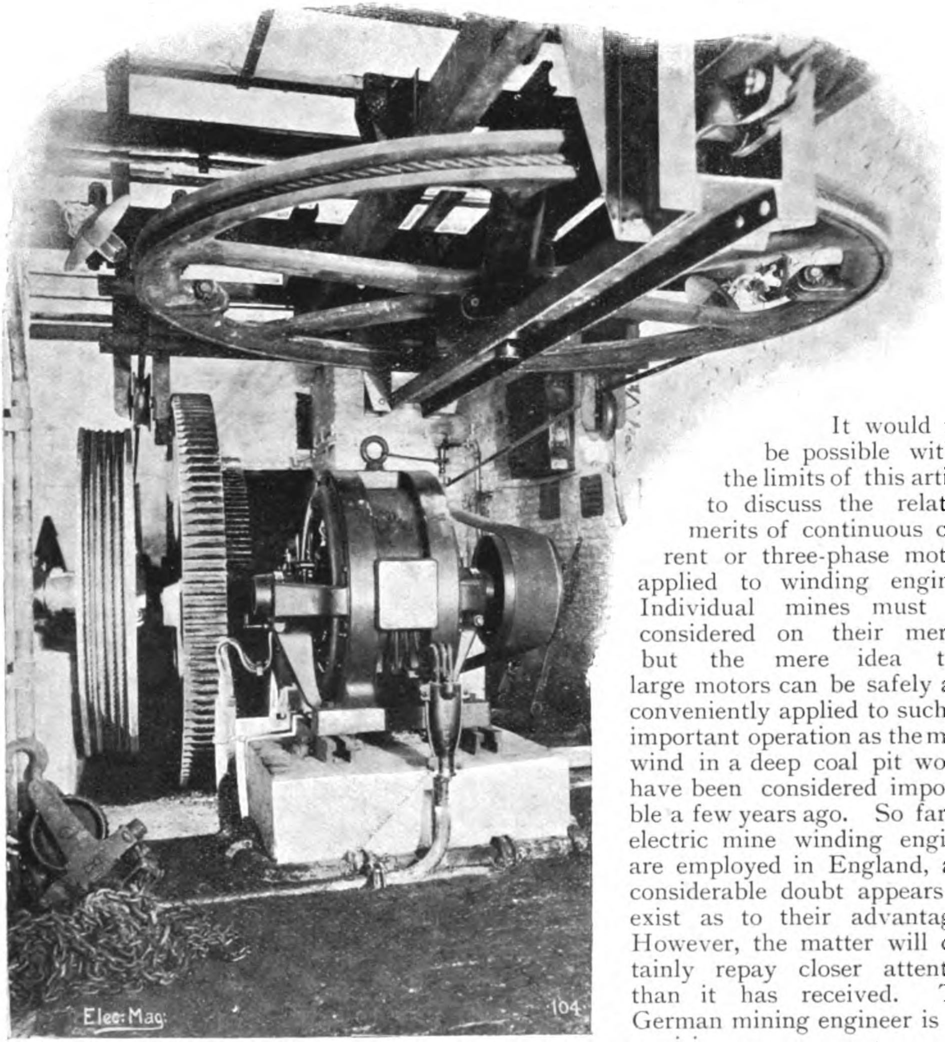


Fig. 13. 60 H P Polyphase Underground Hauling Engine.

the winding drum, is supplied from a continuous current generator, which in its turn receives energy for its magnet circuits from a small belt driven dynamo. The main controller varies the amount of current flowing round the magnet of the primary generator, and this can be increased till the voltage in the motor circuit rises to 500 volts, which corresponds to a speed of from 72 to 80 revolutions of the motor. The power absorbed by rheostatic regulation in this arrangement can be kept very small. Fig. 10 gives a very good illustration of the general arrangement of the plant.

It would not be possible within the limits of this article to discuss the relative merits of continuous current or three-phase motors applied to winding engines. Individual mines must be considered on their merits, but the mere idea that large motors can be safely and conveniently applied to such an important operation as the main wind in a deep coal pit would have been considered impossible a few years ago. So far no electric mine winding engines are employed in England, and considerable doubt appears to exist as to their advantages. However, the matter will certainly repay closer attention than it has received. The German mining engineer is not a visionary personage, and it would seem strange that what is found advantageous in Westphalia should be impracticable in Northumberland or Lancashire.

The application of electrical energy to hauling engines and winches will now receive consideration.

The underground hauling engine was one of the first machines to which the electric motor was applied in a coal mine. Anything which got rid of the horse haulage or the wasteful method of piping steam a long distance to the winch engine, would naturally commend itself early to the thoughtful engineer, and now nearly all the up-to-date mines have their complete system of electric haulage below ground. There is a certain similarity about all these machines, but generally three-phase motors are used, and a variety of ingenious arrangements have been devised to facilitate starting. Fig. 11 shows the general arrangement of a hauling gear driven by a 50 h.p. three-phase motor made by Messrs. Siemens & Halske and installed at the Paulus Hohenzollern mine, Upper Silesia. Fig. 12 is a plan of the machine in relation to the main road and the bottom of the pit shaft. The plan shows how the endless chain is led backwards and forwards over the driving drum, and how the slack is taken up by a balancing weight.

The cost of transport by the machine here illustrated, which has been in use since May, 1897, amounted to from ½d. to ⅜d. per kilometer ton, whereas with the earlier horse traction the cost reached 1¼d. to 1½d.

Fig. 13 shows another underground hauling engine, installed at one of the mines of the Harpener Co., of Dortmund, by the A.E.G. of Berlin. In this case, an alternate current motor of 60 h.p., working at 1,000 volts, runs at 720 r.p.m., and transmits the power by means of a belt to the winding gear shown on the left side of the illustration. The tightening carriage for the wire rope is shown in the foreground above the motor.

Although the underground hauling engine has been in some instances superseded, or rather supplemented, by the electric locomotive, the electrically driven hauling engine seems likely to keep its position for underground transport.

(To be continued).

Percy R Allen

TWO LARGE WATER-POWER INSTALLATIONS.

By ENRICO BIGNAMI.

* * *

The geological formation of the greater part of Switzerland, abounding in vast acclivities and possessing a humid climate, renders this country the natural home of hydro-electricity. A great development has been proceeding there in the utilisation of natural water-power for the generation of electrical energy, and it is with pleasure that we publish the following description of two recent additions to the Swiss electrical water-power plants, furnished us by our correspondent, Mr. Enrico Bignami.—[ED.]

* * *

Two new generating centres in Switzerland are those of Hauterive and Montbovon, situated in the Canton of Fribourg, and these will be of interest. One description will apply to both of these installations, for they have been executed to the same design, and are in every detail complimentary to each other. They have been intended, indeed, to serve as reciprocal reserves to each other, in supplying two distributing systems, which, connected together, have an unique supply area in the Cantons of Fribourg, as well as those of Berne and Vaud.

I will commence my description with the installation of Hauterive, which is destined to become, in course of time, of considerable importance. This plant, which is under the control of the Fribourg

State authorities, derives its energy from the river Sarine, which has its source in the Bernoise and flows into the Aar. The flow of the Sarine is very variable, but a portion is diverted to the turbine house, where there is an effective fall of about 200 ft., in connection with a dam which has been constructed. The maximum output of the installation is about 9,000 effective h.-p., and never fails below 6,000 h.-p. The barrage consists of a stone embankment, 209 ft. long, 24 ft. wide, and 26 ft. high, rising 5 ft. above the normal river bed. It crosses the bed of the river, and takes in at its extremities two walls parallel to the course of the river, the water of which is thus deviated into a canal (Fig. 1), leading to a subterranean tunnel.

The canal is provided at its entry with six sluice gates. At the other end there is a weir and a cleaning gate, by which the flow of the water is regulated on its entry into the tunnel and the bed of the canal cleaned from the deposits brought into it by the current. The tunnel, which forms the chief part of this section of the undertaking, runs on the right-hand side of the river, and during its course approaches quite closely numerous curves of the river. A number of sluice gates are used which permit the flow of water into the tunnel to be regulated. The tunnel altogether is about 1⅓ miles in length, and has a section, from roof to bottom, of 50 square feet, of which only 32 are normally utilised.

The lines of steel pipes will ultimately convey the water to the turbines, but at present only two have been laid. Each range is 137 yds. long, the first 110 yds., with an inclination of 60 per cent., being embedded in rock. The sections are 19 ft. 6 in. long, and have an internal diameter of 5 ft., the thickness varying between 1 in. and 3 in., according to the working pressure.

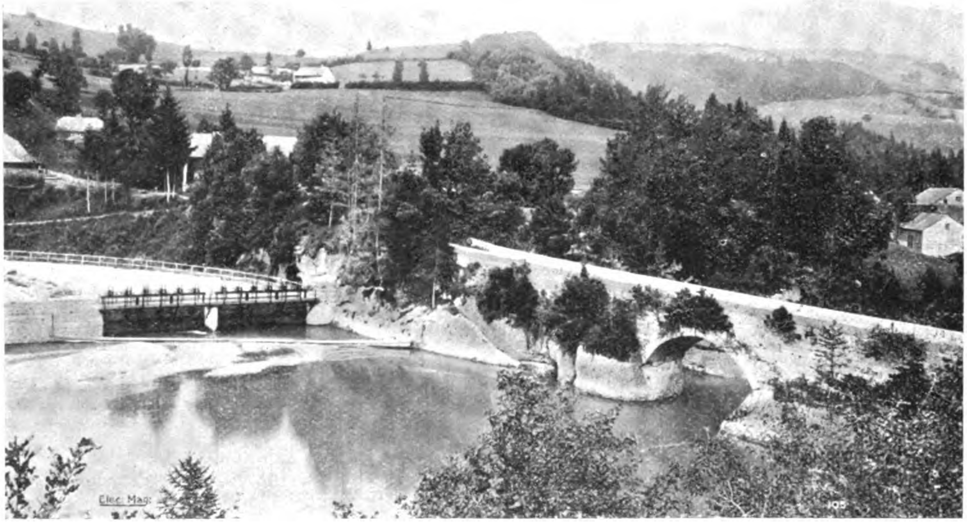


FIG. 1. HAUTERIVE. ENTRANCE TO CANAL.

The generating station (Fig. 2) is comprised in a large rectangular building, 205 ft. in length by 65 ft. in width. The dynamo-room occupies the total length of the building, taking a width of 38 ft. Below the dynamo-room the turbines are placed. That portion of the building, parallel to the dynamo-room on the principal façade, is divided into several floors. The first is occupied by cable connections, and the second by the measuring instruments at the extremity of the lines. At the two ends of the building are situated two towers, in which are the lightning arresters and other apparatus connected

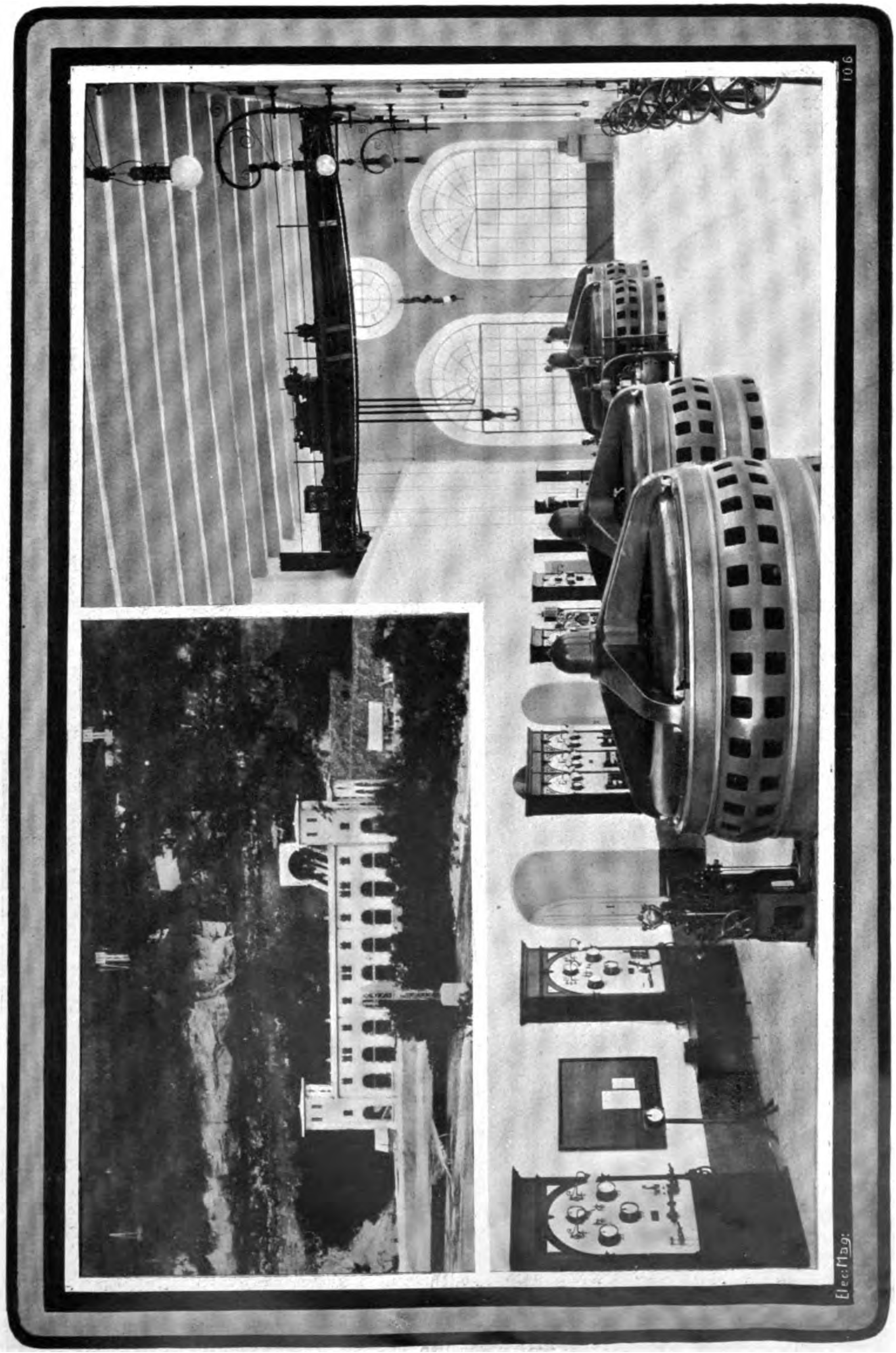


FIG. 2. HAUTERIVE POWER HOUSE. EXTERIOR AND INTERIOR.

with the high-tension overhead conductors. The building itself is designed for the accommodation of ten turbo-alternators and three turbo-continuous current machines, which serve as exciters. At present four alternating sets and two continuous current sets are actually installed.

The turbines, supplied by Piccard Pictet & Co., are of the vertical axis type, and have been designed for an effective fall of 196 feet. They run at 300 revolutions per minute, and the efficiency guaranteed under full load is 75 per cent. The speed variation under normal full load conditions does not vary more than 1 per cent., while the sudden throwing off of full load caused a variation of 3 per cent. only. The turbines operating the exciters are of the same type as the main turbines, and they discharge 2280 gallons of water per minute, and take a fall of 164 feet at 600 revolutions per minute.

The alternators, exciters, switchboards, etc., have been constructed by the Société d'Electricité Alioth, of Münchestein, which firm has also provided the whole of the electrical material for the equipment of the Montbovon installation, which will be referred to later.

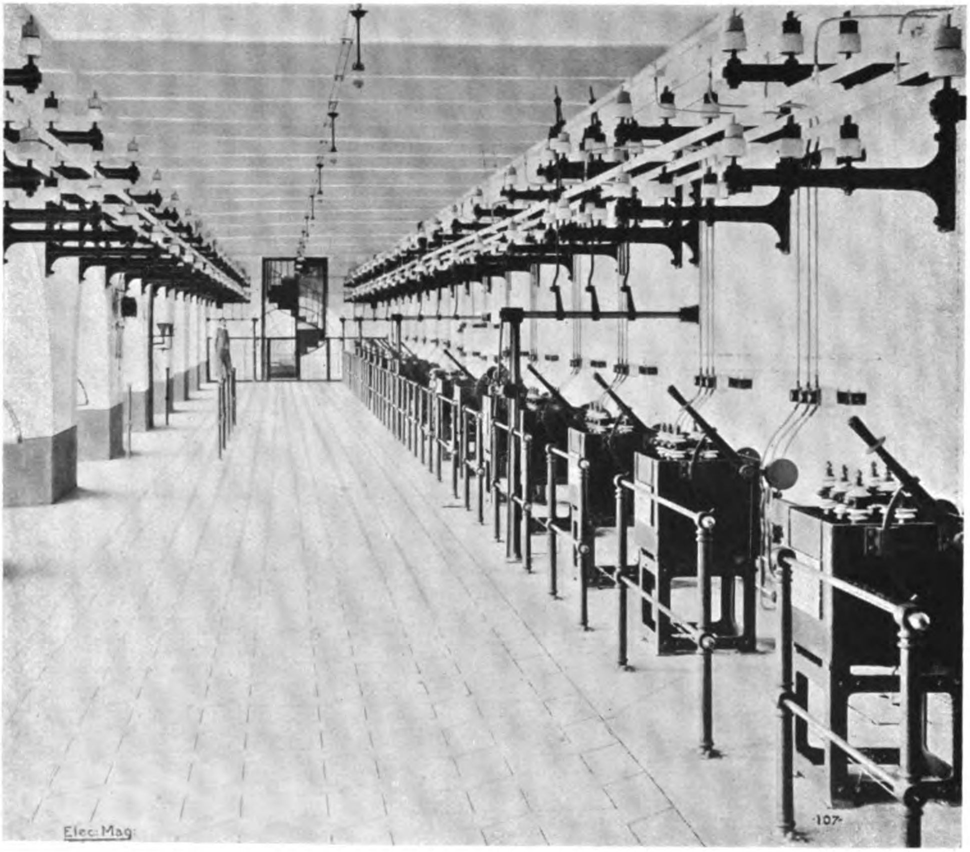


Fig. 3. Hauterive. H.T. Bus Bar Chamber.

The alternators are of the vertical axis type, and have been designed for an output of 950 K.W. at 8,600 volts; and a frequency of 50 periods per second. Exciting current is supplied by independent generators at a tension of 120 volts, 60 amperes, current being required for full load excitation. Each alternator weighs about 43 tons, of which about 13½ tons form the revolving portion. The external diameter of the stator is 11 ft. and internal diameter 7 ft.

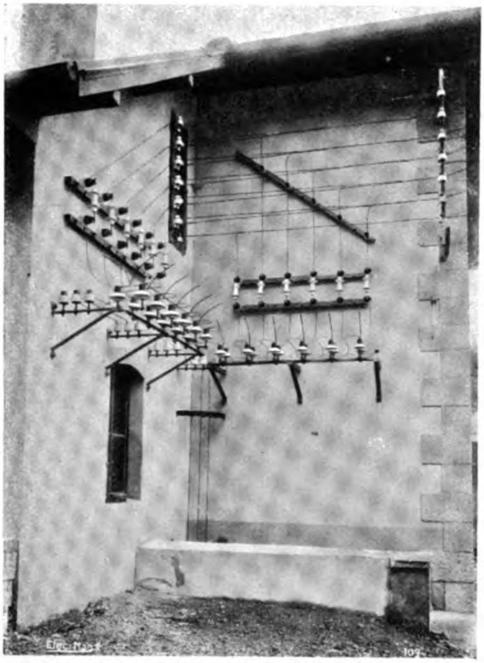


Fig. 4. Montbovon Lightning Arresters.

6 in., the air gap being ·39 in. The exciters are also of the vertical type, with an output of 66 kilowatts, at 125 volts, when running 600 revolutions per minute. One of these generators is in itself amply sufficient to furnish current to five alternators.

In designing the installation every care has been taken to render each unit as independent as possible. The exciters have their own switchboard, and each alternator is provided with a special separate switching chamber, in which is located the controlling apparatus, measuring instruments, etc. This part of the installation is a peculiar feature of these works. It allows for the efficient protection of high-tension instruments and conductors, but in spite of the isolation of the panels, the parallel working of the alternators presents no difficulties. Each turbine is provided with its own speed regulator, and the voltage is controlled by a machine field rheostat. In addition, there is an arrangement by which the tension of the whole of the machines in service can be controlled by an automatic regulator, acting on the field of the exciters. The main current is conducted to the switchboards and from there to the connection chamber, where it passes through two oil interruptors and cut-outs, which permit of its distribution to either of the two sets of aluminium bus bars forming a continued circuit in the chamber. These bars carry numerous sectionising switches (Fig. 3) which allow circuits to be cut out and to isolate each two machines, without stopping the installation. Hydraulic resistances in the alternator circuit allow of the gradually raising of the pressure on each machine to the normal bus bar voltage. Current transformers are placed in each phase, and are connected through a commutator to a common ampere meter. Each line, before its exit, can be interrupted by an oil-bath, with cut-outs. In connection with each line there have been installed lightning arresters, with a water resistance, which work perfectly, absorbing only about five amperes of current.

Associated with the installation of Hauterive is that of Montbovon, which is controlled by the Société des Usines Hydro-Electrique de Montbovon. This installation also utilises the water of the Sarine river. The barrage directs a portion of the flow into a subterranean canal nearly 2 miles in length, 11 square yards in section, which penetrates the rock. Two pipes

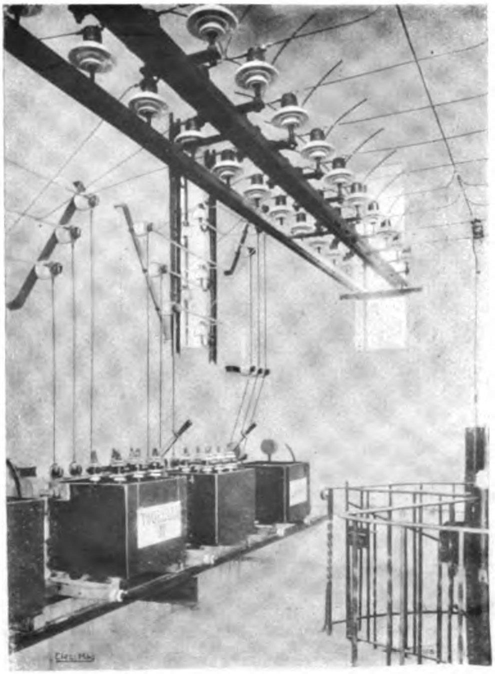


Fig. 5. Montbovon Hydraulic Resistances.

pierced through the rock lead from the water chamber and supply the turbines installed in the works. These lines have a length of 200 yards, and are formed of rivetted steel pipes similar to those at Hauterive. To avoid the damaging effect of the blows on the rivetting, made by the turbine flanges, compensating wings have been installed on an automatic principle in connection with the regulator.

The generating station like that of Hauterive is of rectangular form. In a central outbuilding, behind the main dynamo room, are installed the exciting generators. The two wings are occupied with a repairing workshop, stores and offices, and on the first floor are placed the interruptors and cut-outs. The lightning arresters are mounted on the exterior of the two angles formed by the outbuilding. (Fig. 4 and 5).

The total capacity of the generating station is 5,600 effective h.p. There are four sets of turbo-alternators, of 1,100 h.p. providing exciting current. The turbines are analogous to those of Hauterive, and have been constructed by J. J. Rieter & Co., of Winterthur. They are vertical type, and run at 300 revolutions per minute. The speed regulator is of hydraulic type, utilising water, cleaned by passage through a filter, under full pressure.

The details of this portion of the installation are identical with those of Hauterive, excepting in the case of the exciter dynamos, which are of the horizontal axis type, and differently connected with the turbines. A double transmission system runs through the dynamo room, above the alternator switchboards, which connect the field rheostats, and allows the regulation of the tension of the machines in use. The current is conducted from the switchboards to bus bars and thence to eight overhead three-wire circuits. Each conductor, as at Hauterive, is connected with a lightning arrester, with hydraulic resistance. The main conductors have a section of 1¾ square inches, and are generally spaced in the form of an equilateral triangle at a distance of 19 inches from each other. Most of the circuits are on the double system of conductor (6 wires).

From the generating station at Hauterive proceed a number of circuits, to the chief centres of use:—Payerne, Avenches,

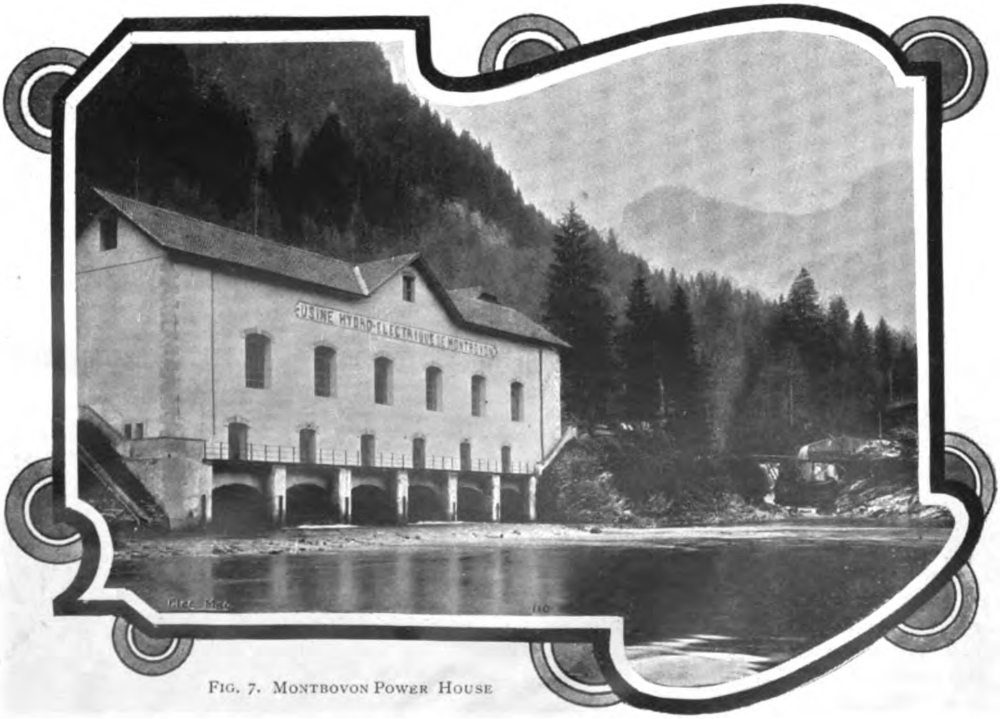


FIG. 7. MONTBOVON POWER HOUSE

Morat, Fribourg, etc. The Hauterive-Romont circuit is intended to connect the systems of Hauterive and Montbovon for reciprocal assistance. The eight circuits which are supplied by the Montbovon generating station, are served in three different directions. One main conductor supplies the district of Montreux; the second, Châtel-Denis and Semsales, from where it bifurcates on Mezières and Romont; the third covers Payerne. The main supply lines are interconnected at the transforming stations, and a regular and continuous service is thus assured to the various districts. Sectionising arrangements are provided, which permit of subdivision of the lines if necessary. The sections thus formed are supplied by a secondary network, at a lower tension. The chief industrial centres are supplied through one or more transformer posts, lowering the tension from 8,000 to 110 volts if the service is concentrated, or to 190 volts if the zone of supply is extended.

Some districts, of a wide extent and sparsely populated, are supplied by a secondary circuit of 500 volts from a transformer post, from 8,000 to 500 volts. On this circuit again are other transformer stations, reducing the voltage from 500 to 115 volts, for the lighting of the hamlets and villages, whilst motors are installed direct at 500 volts. Electrical energy is thus distributed to thousands of inhabitants in the Cantons of Fribourg, Vaud, and Berne.

The supply district is almost wholly agricultural, and energy is mostly utilised for lighting, while motors are employed in connection with tile works, saw-mills, forges, and workshops generally. Among the more important applications of electrical energy thus provided, may be mentioned several electric railways, supplied through rotatory transformers, which have acquired a considerable development. The Hauterive generating centre supplies in this way the Fribourg-Morat Railway, the Montbovon station supplies those of Lausanne-Moudon, Vevey-Chamby, Châlet St. Denis-Palézieux, La Gruyère, and that of Montreux-Oberland Bernois.

A most moderate tariff has been fixed for electrical energy in these Cantons, which facilitates the development of existing industries and stimulates the foundation of new.

Enrico Bignami

⁂

THE APPLICATION OF ELECTRICITY on the Oil Fields.

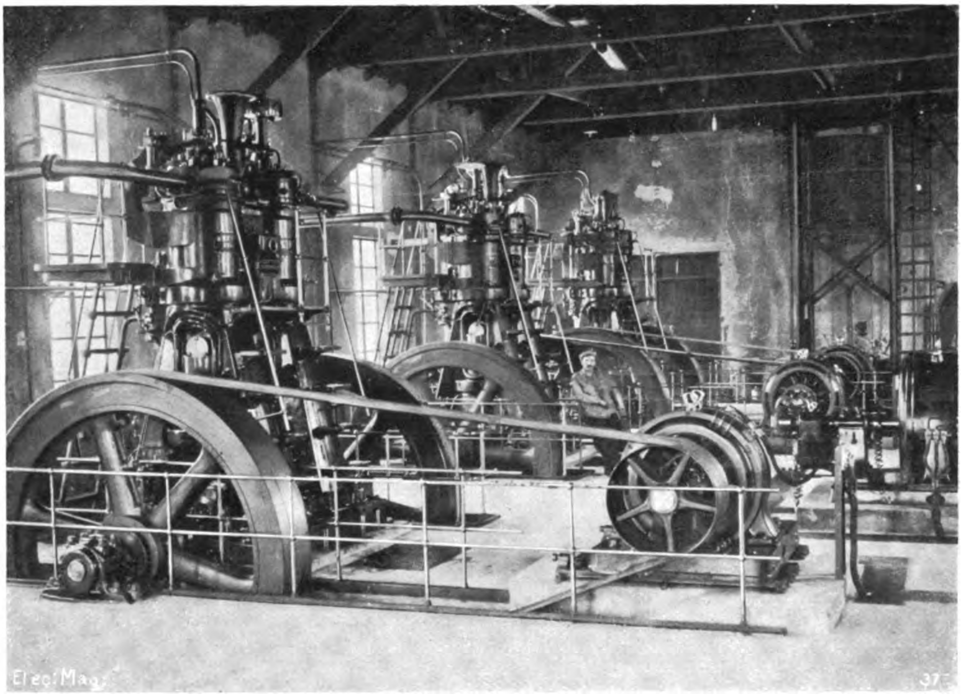
By L. GASTER, A.M.I.E.E., etc.

(Continued from page 39).

For lighting purposes little comment is needed on the use of electric lamps, save that the insulation of the leads should be of first-class material to resist the attacks of oil and oil vapours. Failing this, considerable damage may arise. The use of enclosed arc lamps is still receiving consideration. Apart from power and lighting purposes, electricity can be used for welding pipes and boring tools, while as a magnetic agent for recovering broken tools, dropped either accidentally or deliberately into a boring, it can render invaluable service. With exceptionally cheap electricity distillation of the oil may be undertaken by applying heat directly in the bulk of the oil, the entire heat generated being utilised, while the regulation can be conducted and maintained with great accuracy and constancy.

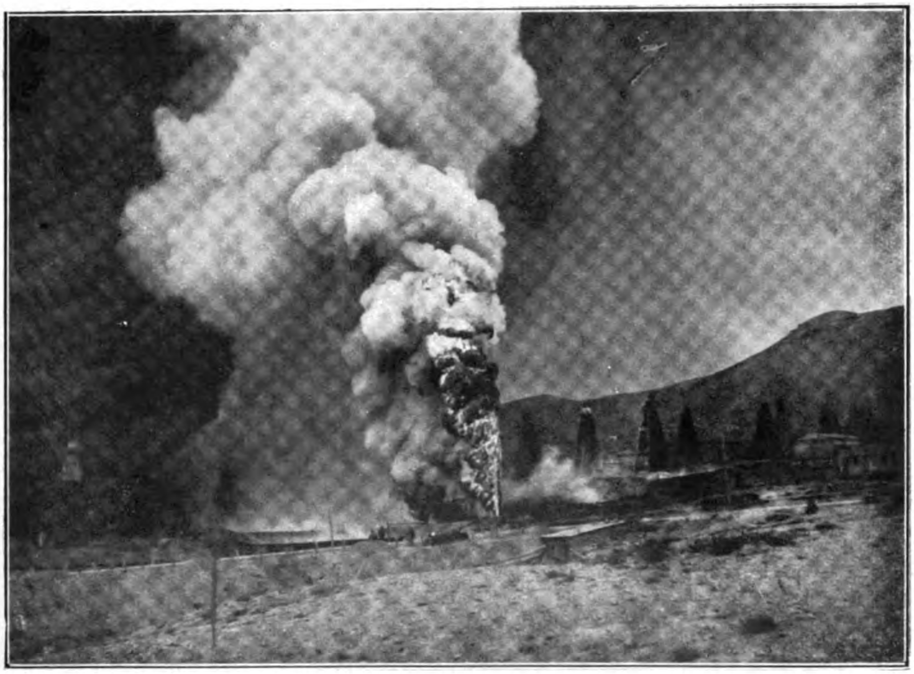
In the author's opinion there are excellent prospects before this method for the distillation of lighter products, such as benzine, etc., or for the refining of the more expensive products requiring a constant temperature, and experiments on a large scale are only needed to illustrate the value of the process.

The history of the application of electricity for boring purposes is only five or six years old, and though comparatively brief is of considerable interest. The author prefers to start with the smallest rather than the largest petroleum producing country, namely Roumania, as electricity was first applied on its oil fields. The first electrical installation for drilling and pumping purposes was established on the property of a Dutch Company, about five years ago. Water power was utilised, and a double Francis type turbine of 235 h.p. running at 160 revolutions per minute was coupled direct to a three-phase current generator of 200 K.W., delivering energy at 330 volts. This voltage was raised to 3,000 and transmitted to Campina, 2·5 kilometres (1½ miles) distant, where it was transformed down to 300 volts, this being the motor pressure. This installation, though not working now, is of historic interest as being the first of its kind in Roumania. A much larger installation was erected shortly afterwards by the "Lahmayer Company" for the "Steaua Romana" Company's oil fields, which the author had occasion to visit last year. Water power is utilised to develop about 1,500 h.p., there being 4 turbines, coupled direct to three-phase generators each of 350 K.W. capacity, supplying power at 3000 volts when running at 250 revolutions per minute. The voltage is raised by step-up transformers, near the central station, to 11,000 volts and transmitted to Doftana, a distance of about 21 miles, where a reserve station is erected. From that place the current is transmitted thence to Campina and Bushtenari, the former being 3¾ miles, and the latter 6¼ miles distant from the reserve station. The oil fields can be supplied either direct from the central station or from the reserve station, or from both places at the same time in parallel. The maximum available water power is 1,500 h.p., but during a number of months in the year this is not available to supply the oil fields. The secondary station at Doftana has accordingly been provided with sufficient spare plant to take almost the entire load required on the oil fields. Again the central station has been called upon to furnish the current for lighting the town Sinaia and the King's Castle. At the reserve station, the Diesel oil engine has been applied on a somewhat large scale. These engines will operate with crude oil, and are therefore very well adapted for use on oil fields. Three engines of 100 h.p. each are belted to a similar number of three-phase generators. The consumption of oil, according to a test taken at the time of the author's visit, was about 0·5 pints per horse power per hour. At the wells very great precautions have been taken



Power Plant at Doftana. Diesel Oil Engines.

by the company to prevent any danger from sparking, the motors being carefully enclosed, and the cables run in insulated tubing, to a point some 65 feet from the derricks. To avoid all possible risk of fire, steel derricks should be used, a portable form having been devised specially for the purpose. When wooden derricks are used, they should be covered with such incombustible materials as uralite, sheet iron, etc. Another cause of fire is sometimes due to "lightning," and great care must be taken to avoid accident by employing proper lightning arresters. The number of motors used by the Steaua Romana Company during last year's visit was about 30 at Campina and 27 at Bushtenari. The motors for boring purposes are of about 30 h.p. each, and in some cases where great depths have been dug (for instance one boring was to be 874 yards) two motors are coupled together, so as to provide the necessary power for raising the rods, tubing, etc.



Oil Well Fire at Bebi Aibat.

The cost of electric installation for boring at Steaua Romana was about £500 per well, but the running cost was less than £8 per horse power per year of 360 days and 24 hours per day. This is much lower than when scattered engines were used, with boilers fired with liquid fuel. Although the initial cost of an electric power installation, if erected by the owner of the oil fields, may be higher than a steam installation, the running costs are much smaller with electric motors. If, however, the necessary energy is supplied from a central station, having a large number of power consumers, the owner of the oil fields has only to buy the motors, and pay for the current utilised. In this case the economy in favour of electric power is more marked, compared with boilers and engines scattered about the oil fields.

The use of electricity for boring purposes is rapidly spreading in that country. Before leaving the subject of Roumania, it may be remarked that the running expenses on the installations in that country showed a saving of over 40%; but this figure depends to a very large extent upon the circumstances under which the work is carried out, on the management, and on the price of fuel. The latter may be taken to amount to over 30% of the total expenses, therefore, if any economy can be made in this respect the price of generating electric current is reduced accordingly. This point is particularly dwelt upon here in order to explain why the application of electricity in Russia (dealt with subsequently) has not made such rapid strides during the past few years as were at first expected. Considering now the state of affairs on the Russian oil fields, it is interesting to note, at the outset, that the leaseholder of the Government plots for petroleum exploitation are free from royalty for any oil they consume on their own property, for power or pumping purposes. When this oil is used outside their property for a similar purpose, a royalty must be paid for it: consequently, the would-be consumer of electric power is not disposed to adopt that system, because the economy possible by its use would be discounted by the increased fuel item if the electricity were generated outside his oil fields. Until the Government allows a certain percentage of oil to be used for fuel purposes free of royalty, the use of steam boilers and engines supplying motive power on the different plots will still give rise to the danger of fire. The author understands that the Minister of the State of Domains has already been presented with a petition for amending the law relating to this fuel item by the Technical Society for the Preservation of the Oil Fields of Russia. If a satisfactory solution of the question is the result, electricity is sure to become enormously used throughout the whole extent of the Russian oil fields.

The first station erected in Russia was at Balakhani, three years ago, and almost simultaneously, an electric plant was installed by Messrs. Nobel Bros. The former station was proved to be too small for the requirements of the fields, so power is now taken from the largest company in Russia, *viz.*: the Electric Power Company. The first Electrical Power Station for commercial purposes was completed in the spring of 1901, by the "Apscheron Electric Company," Baku, who gave the "Allgemeine Elektrizitats-Gesellschaft," of Berlin, an order for a station of 1,500 h.p. Two 750 h.p. steam engines were erected to operate two three-phase dynamos of 700 K.W. capacity each. Current at 6,500 volts is transmitted and transformed to a lower voltage for use by the motors on the oil fields. Steam boilers have now been discarded over the whole property belonging to the Caspian and Black Sea Society at Bebe Aibat, and replaced by electric motors working very satisfactorily. The latest and largest company floated is the Electric Power Company, which upon its formation, acquired the Electric Light Station at Balakhani, Bebe Aibat, in Baku City, of the Sviet Company. In addition they erected two other stations—one at Bebe Aibat for supplying the Bebe Aibat fields, and the other at White City for the oil fields which were situated near by. The station at White City was completed at the beginning of 1902, and comprises four 1,000 h.p. steam engines, and one of 2,000 h.p., and is one of the largest central stations. Several other installations have been erected in other parts.

In America, one of the largest petroleum producing countries, only very recently, one or two of the more prominent companies have adopted electricity for boring and pumping purposes. A large installation erected at Folsam Wetzel county, Virginia, belongs to the South Penn Oil Company. The plant consists of two vertical, triple expansion, condensing engines, each of 375 h.p. of the William type, running at 300 revolutions per minute, and directly connected to two 250 K.W. three-phase generators. Current is generated at 600 volts. 25 cycles per second. For greater distances than one mile the pressure is raised to 6,000 volts for transmission to sub-stations, where it is transformed down again to the voltage required by the motors. In each case the erection of the installation has been followed by very successful results.

From the foregoing it is safe to predict that great progress will be made in the more general adoption of electricity on oil fields in the near future.

The application of electricity for boring and pumping oil wells should increase materially the supply of oil, especially if other productive fields are discovered, a circumstance which would be quickly followed by a reduction in the price of petroleum. If the outcry that the coal supply of this country is nearing exhaustion may be taken seriously, the difficulty could be best met by adopting liquid fuel. As long as the prices would allow us to do so, the coal of this country should be kept in reserve, until petroleum became either dearer or no longer available. The electrical industry of this country should seize an early opportunity of including the numerous oil fields on the continent in the list of those industries needing electrification. There are thousands of boilers used in the oil fields now, which will have to be replaced sooner or later, and many more borings will be needed, to satisfy the growing demand for this valuable commodity.

Leon Gaster.

* * *

The Publishers of *The Electrical Magazine* have made special arrangements for the supply to Annual Subscribers, of a card index of the contents of the Journal as it appears. The whole forms a neat desk set, containing information of incalculable value to the Professor, Consultant, Technical Expert, and Manufacturer alike. Write for full particulars.

POWER: and·its·application·to· INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

Power Supply in Bulk in Great Britain.

By W. E. WARRILOW.

AMONG the five or six power schemes operating in England, one only, the Newcastle-on-Tyne Electric Supply Co., can boast of a load in any way commensurate with the initial aims and plant capacity of such undertakings. Starting in January, 1900, the supply has reached 6,400 K.W. in four years, and is now rapidly increasing. In addition to securing as customers some of the largest firms in the district, a tramway company and an Urban District Council, its future prospects are greatly enhanced by the acquisition of the North Eastern Railway Co. as a consumer in bulk, for its local electrified lines.

The large power load secured, apart from direct current to tramways and railways, is a splendid testimony to the standardization and subsequent success of three-phase systems. Moreover, it augurs well for power schemes, now in course of development, adopting this method. Once a regular supply is started the multiplication of motors, and especially induction motors, becomes a comparatively easy matter, as prompt delivery can generally be relied upon from makers of standard designs.

Pending the standardization of prime movers in this country, it is improbable that the time now occupied between the granting of powers to supply companies and the delivery of energy will be materially reduced. Unlike countries blessed with abundant water power, where wheels designed and constructed on a common principle can be quickly installed, we are handicapped in our zeal for economy by the limited choice of prime movers whose bulk shall be proportionate to their output, and which shall yet be procurable in recognized sizes.

Water-power stations are at present conspicuously absent from the *rôle* of operating schemes supplying energy in bulk in these islands, though projectors are not wanting daring enough to hazard the success of such an undertaking in the face of apparently adverse conditions. North Wales and the Shannon river are to be the scenes of the first endeavours in this direction; and although developments will be closely observed, water-power plants in this country can never secure the same degree of support accorded their steam and gas-driven rivals.

In steam circles, the turbine of that ilk has already cast reflections on the clumsy though serviceable reciprocating engine, and in this respect the records of the two large power schemes installing steam turbines will be awaited with unusual interest. Large gas driven stations have yet to establish themselves, though the North Western Electricity and Power Gas Co., in the four years grace it has for commencement of supply, may establish a precedent in this field of heavy electrical engineering. The general progress of the operating schemes is not perhaps so sluggish, when due regard is had to these retarding influences which are peculiar to this country.

When our present efforts at standardization, more especially of generating plant, are productive of definite results, we may become less and less the objects of scorn of countries more favoured with natural power and less hindered by constructional difficulties than we are.

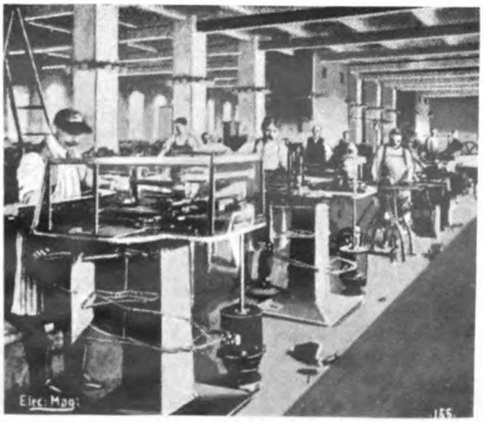
In the Finance and Legislation Section will be found particulars of the Power Bills now before Parliament, and of new powers sought by existing companies.

THE LARGEST PRINTING OFFICE IN THE WORLD,

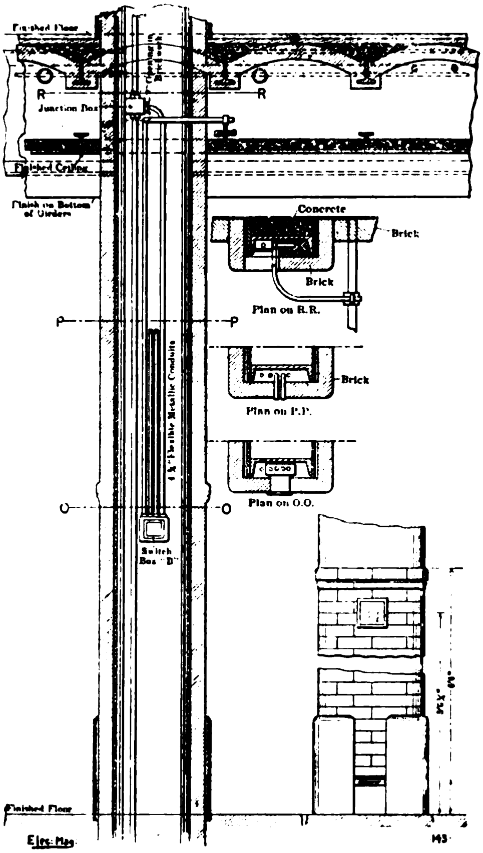
And its Electrical Equipment.

WASHINGTON is at present the home of the largest printing establishment in the world—the U.S.A. Government Printing Office—comprised in a building having eight acres of floor space and employing 4,000 hands. An undertaking of this magnitude designed for printing purposes alone, has points of interest to printers generally, and though we are here concerned with the power installation, a brief reference to the bulk and character of the work will serve the double purpose of recording some weighty figures and impressing our readers with the importance of the electrical equipment. £1,300,000 is annually expended, but the necessity for such a heavy disbursement is evidenced by a glance at the work done and the stock carried. 100,000 reams flat, and 110,000 reams roll are annually consumed for books alone; three million sheets of Bristol and cardboard, 1,700 reams of cover paper, 35,000 reams of writing paper, 10,000 reams of coated book paper, are also among the annual "items" of the establishment. 30 to 35 tons of paper is the daily consumption of the machines, and 700,000 volumes of departmental reports are stored ready for distribution. The *Congressional Record*, for instance, published during Congress, with a circulation of 23,000 single copies, containing 192 pages, is regularly run off daily to catch the 5.30 a.m. train. A record may be cited in the speed of production by the issue of the report of the blowing up of the Maine. The MS. was received at 6.30 p.m. one day, and a copy was placed on every desk in the Senate and House the following day at 10 a.m., the report comprising 298 pages and 24 full page engravings.

The original power plant of 425 K.W. capacity supplied energy at 125 volts, and this pressure, after some discussion, was adhered to when extensions were carried out; the additions brought the total output to 1,025 K.W. The dynamos have a full load efficiency of 94 %, and of 93½ % at ½ load, being equal to 25 % overload for four hours. With 125-lbs. steam pressure, a consumption of 15½-lbs. of water per 1-h.p. was obtained, the vacuum being 26 in. Eight 300-h.p. Scotch marine boilers, 12-ft. diameter by 14-ft. long, supply the requisite steam, and a special form of shaking grate is employed. A coal storage of 1,200 tons is provided. The electrical apparatus in the power house calls for no detailed comment, the distribution and application of the energy generated being worthy of the most special note. The wiring, or "cabling" it may be better termed, was carried out by the printing office staff, and the results reflect creditably on their exertions, considering that some 75 miles of wire have been installed.

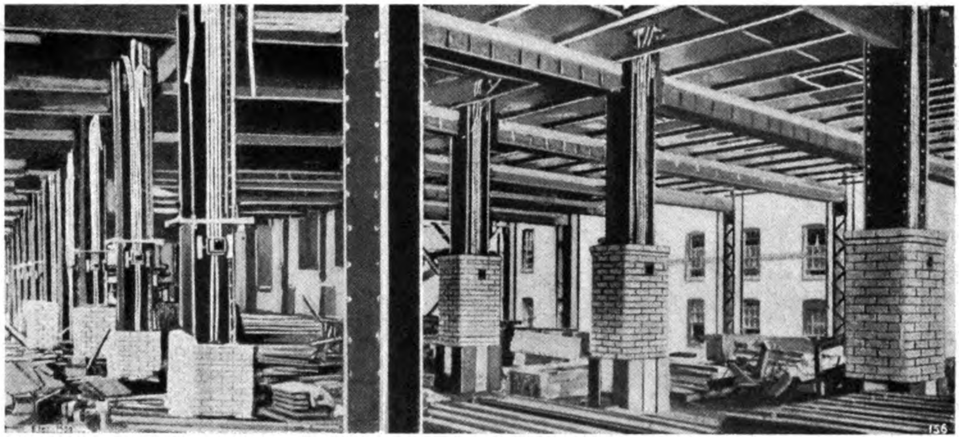


U.S. GOV. PRINTING OFFICE. ELECTROTYPERS' ROOM



U.S. GOV. PRINTING OFFICE. CABLE AND VENT SHAFT.

Every precaution was taken to obviate fire risks, and the system of cable-running is a monument to the labours of the engineers. The adjoining illustrations depict clearly the manner in which girders have been utilised. Porcelain insulators, hangers, and every known method in cable work of combining mechanical strength with accessibility have been taken advantage of, while the function of the building as a fire-proof structure has been in no way impaired. The power circuits are continuous from the switchboard to the distributing



U.S. Gov. Printing Office. Cable Ducts and Wiring.

centres, and are carried through the floor to the various motors, all lighting leads, in contradistinction, passing through the ceiling.

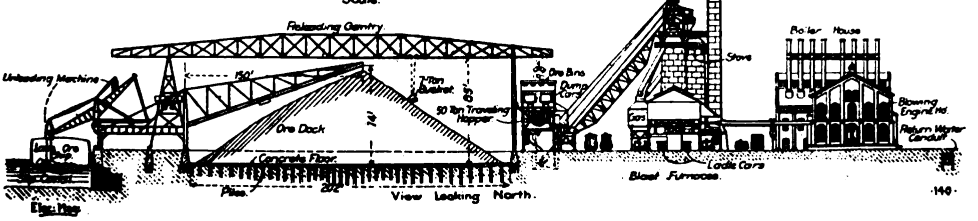
The elevator equipment, which is on an extensive scale, includes thirteen large passenger and freight lifts, and two forme lifts, the latter being controlled by push buttons. The larger sizes are worked from a duplicate electrically-driven equipment in the basement.

Currents for heating in several processes peculiar to this class of work have been employed to an extent not hitherto attempted in any printing works. Matrix drying, wax stripping and melting, case warming, "sweating on," and soldering are all equally well carried out, as well as embossing, glue heating, and cover shaping. The stereo melting pots only are heated by gas. The adoption of electric heating was confirmed in practice by the increased production resulting from the control over the temperature obtained. Where high temperatures or rapid rates have been found necessary, voltages giving a maximum mechanical strength to resistances were obtained from suitable transforming apparatus. The printing presses are all driven electrically and chiefly by independent motors. The entire installation is an object lesson to printers, the world over, of what can be done with electricity in every process of the typographic art, and we shall look forward to a move on some such magnificent scale in the departments of our own Government at home.

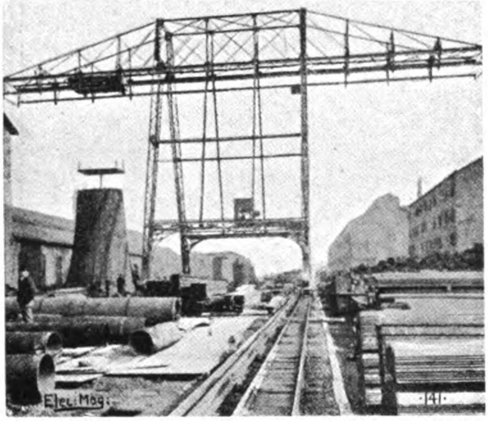
ELECTRIC POWER IN STEEL WORKS.

The steel works of the Lackawanna Steel Co., Buffalo, N.Y., possess engineering features alike interesting to electrician and metallurgist. The production of steel in large quantities is now almost commonly conducted by the aid of electricity, but the plant in question will bear reference and illustration, while presenting a valuable object lesson. The company has a capital of $40,000,000, and was formed in 1902 to absorb the Lackawanna Coal and Coke Co., which owned bituminous coal properties. The plant to which we here refer is only partly completed, but a great portion is in successful operation. The buildings have been laid out on a strip of land 3½ miles long near Lake Erie. A canal for ore-carrying vessels has been cut on this side of the property, while inland a railroad connects the works with trunk and main lines in Buffalo.

Steel is produced from raw material alone, so that all the processes of coking, smelting, Bessemer and open hearth steel making and rolling are involved, in addition to which large stores of ore, coal, etc., have to be carried. The by-product coke ovens, for instance have a capacity of 4,000 tons a day, and 150,000 tons of coal is stored in circular piles commanded by revolving electric loco-cranes. An ore dock also, 2,500 ft. long, by 270 ft. wide, has a capacity of 750 tons per lineal foot, the ore



Lackawanna Steel Works. Electric Ore Unloader.



Lackawanna Steel Works. Electric Gantry Crane.

being piled about 70 ft. high in the middle. Five ore unloading machines electrically operated, travel from end to end of the ore dock, and transfer the raw metal from vessel to dock. Three ore reloading machines, also electrically driven, convey the ore to steel bins on the opposite side of the dock, where the different grades are sorted out.

In these cranes the walking beam truck and ten ton bucket are operated by motors, with adjacent controllers, the switches being electromagnetically operated. This arrangement dispenses with the heavy cables which would otherwise have to be run down the leg of the walking beam.

After weighing, the ore is hauled by cable to the furnaces, and discharged by automatic electric machines. Two 300 ton furnaces are at present in use, but four of 800 tons capacity are erecting. In adapting the works for electric power, the steam engine has, doubtless from experience gained elsewhere, been adopted in preference to the electric motor for the roughing and blooming mills. Steam and gas engines figure prominently in the equipment, the former being chiefly used as mentioned above, and the latter for blowing purposes. The boiler plant presents some novel features in that vertical boilers, each of 250 h.p. and with a separate stack, are used. One house contains 80 of these, aggregating 20,000 h.p.

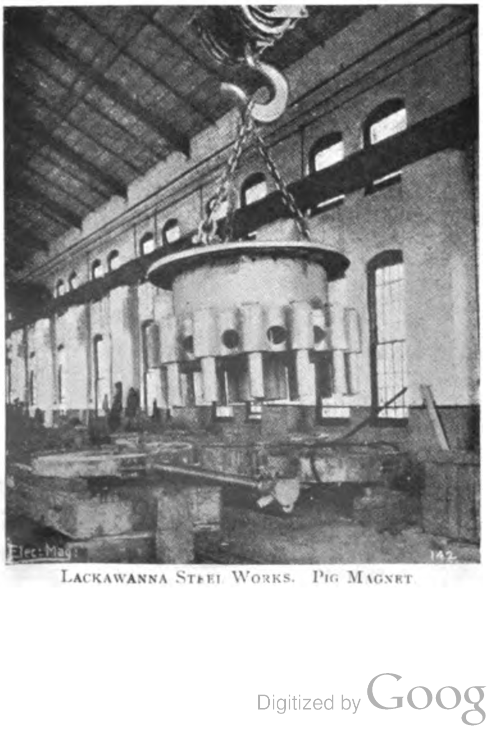
Alternate and continuous currents are generated by gas-driven units, the dynamo being mounted centrally between two horizontal engines. Ten sets of 500 K.W. each are installed, five direct, and five alternate current machines, all gas driven except one reserve d.c. steam unit. Three series arc lighters, driven by induction motors, are among the other generators in the station. Energy is distributed at 440 volt three phase and 250 volt direct current.

The motors to be used will have an ultimate output of 32,000 h.p. Alternate current motors are used for constant speeds, and d.c. series compound and shunt wound machines are put in service on cranes or in operations requiring frequent reversals. Electric gantry cranes and locomotives are made full use of throughout the yards, an interesting type of the former being a magnet for lifting pig-iron, thrown promiscuously in piles. The magnet shown in the adjoining illustration weighs 3½ tons, and will lift up to 1½ tons. The windings are specially ventilated and the whole magnet efficiently protected against the weather.

Among the unusual applications of electricity may be mentioned a special burner for blast furnaces, which is used to remove the obstruction due to the "freezing" of tuyeres, cinder notch, etc. A 2 in. × 72 in. round carbon is clamped to a holder through which a flexible cable is passed, and connected to one side of the direct current circuit. The other side is coupled to the framework of the furnace. 500 to 1,000 amperes at 80 volts is generally necessary to maintain the arc for burning off the obstacle.

The application of electric motors to the driving of roller tables presented a difficult problem, but this was surmounted by providing an elastic medium between the motor and its load. The rim of a flywheel was driven by means of heavy springs from a spider keyed on the driving shaft, the spider and the inner shaft of the flywheel having a corresponding number of toothed projections. All feeders and mains are lead covered, paper insulated, and run in conduits of tile, specially constructed to prevent sinking in the soft soil. In designing the distributing system the limiting condition was not the drop in potential, but a five watts loss per duct foot in the underground system. All direct current cables are single conductors, while for alternate currents three core cables are used. The yards are lighted by series direct-current arc lamps and 440 volt alternating current is stepped down by tranformers for incandescent lighting. As 25 cycle currents are employed, three lamps, connected between the different phases, are installed near each other, to obviate any disagreeable physiological effects.

We are unable to refer at greater length to this unique steel production plant, which is one of the largest additions to the list of works of this character.

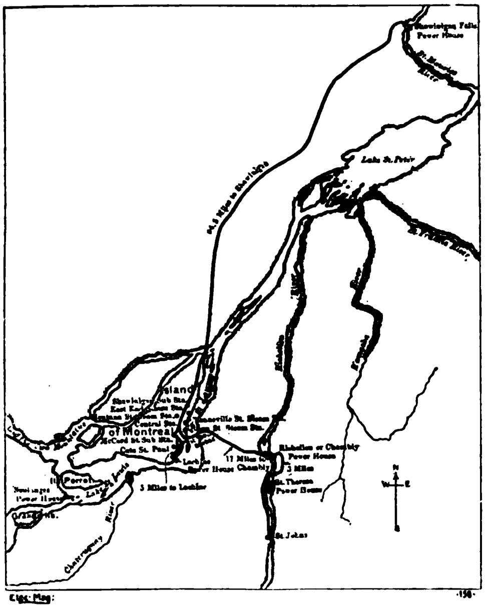


Lackawanna Steel Works. Pig Magnet

THE WORLD'S GREATEST CENTRE OF TRANSMITTED POWER.

THE St. Lawrence, the Richelieu, and the St. Maurice rivers, fed by half a continent, are being developed at every point to furnish power and light to the city of Montreal. Shawinigan, Chambly, and Lachine are the chief water power contributors to the 28,800 K.W. at present generated, while five steam driven plants in Montreal act as a reserve of 5,700 K.W. The present powers of supply are in the hands of the Montreal Light, Heat, and Power Co., a vast organisation, incorporated by the Quebec Legislature in 1901 to consolidate the gas and electric interests, and absorbing some eight companies in the city and suburbs. The proceedings date back to 1884, and have advanced through the stages of small steam plants to the monster water power installations of the present day. This feature is worthy of note, as pointing to the desire for central control of the natural power sources so abundant in the neighbourhood. Space will not permit us to do the full justice which the *Electrical World and Engineer*, in four lengthy serials, metes out to this extraordinary utilisation of water power; but a study of the chief figures and the accompanying map will serve to impress our readers with the magnitude of the undertaking. The Shawinigan Co. is under fifty years' contract to deliver 20,000 h.p. of electrical energy to Montreal, and a power plant at Soulanges will, when completed, transmit power for the city systems. Three sub-stations receive, transform, and distribute the power from the various sources, and all are cross-coupled by 2,400 volt feeders, permitting interchange of energy from all the plants. Prospective developments have occasioned the installation of sub-station plant in excess of immediate needs, the central station containing 27,500 K.W. of transforming apparatus. A total transforming capacity of 39,500 K.W., or 52,000 h.p., is at present in use, excluding the steam plants mentioned above. Fifteen municipalities, all (except two) on the Island of Montreal, encompassed by an area of 56 square miles on the island and 4 square miles on the mainland, are furnished with light and power. There are 11,152 consumers of the former and 870 of the latter, while street lighting claims 1,717 arcs and 577 incandescents. Connected to the system are 299,903 incandescents and 1,514 arcs; the motors aggregating 1,109, or a total of 19,172 h.p., and 695 service transformers are used for this purpose. Many high voltage motors also are connected, as well as direct current machines. The latter, first used in 1892, then averaged 50 h.p.; but in 1900 this figure had risen to 1,253 h.p. In 1897 the polyphase motor appeared, and, starting at 18 h.p., rapidly reached 3,417 h.p. by 1900. In the two years succeeding the starting of the Chambly station in 1899, the rise in the power load was greater than any in the previous decade.

The transmission voltages from the three great water powers are: 50,000 volts Shawinigan, 25,000 volts Chambly, and 4,000 volts Lachine Rapids. Transformation for primary distribution, to 2,400 volts is affected by air-blast transformers, ranging downwards from 2,750 K.W. capacity each. The largest of the sub-stations now contains ten 2,700 K.W. transformers, but will ultimately have sixteen of these monster units installed. This station, which is almost entirely fireproof, is situated in the business part of the city, and in view of its importance the adjacent buildings are kept at a minimum distance of 73 ft. The financial results show a net income of 46% of gross earnings, and this figure has been secured by good engineering. The system in its early stages of isolated companies has been combined, re-modelled, and re-constructed wherever necessary, and the existing efficiency is directly traceable to the vigorous pursuit of this policy. Day loads have been built up, small transformers replaced by larger, with reduction in leakage and magnetising losses, and careful attention paid to the charge for both light and power. With the latter, the contracts for users of power (even to the largest extent) stipulate that supply be discontinued after 4 p.m. This prevents overlapping with the lighting load, and complete success has attended the plan since its inception. Attractive prices are, of course, offered to all power consumers on this basis. The regular rate for lighting is 15 cents per K.W. hour; while to large consumers, like the cotton mills and the tramways, the rates compare favourably with the cost of steam power.



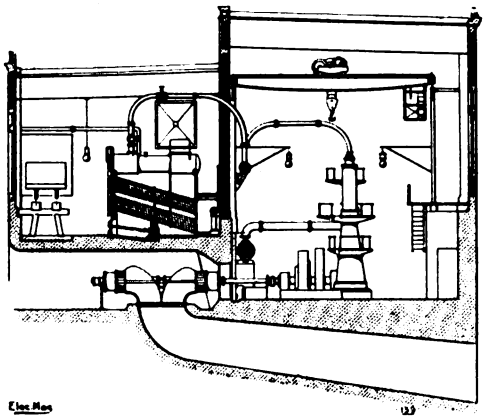
Elec. Mag. ·156·

MONTREAL POWER SCHEME. MAP OF TRANSMISSION LINES.

The Chambly power plant has been re-constructed and extended since it was first put into operation in 1899. The two-phase inductor alternators were re-wound for three-phase working, and new generators of modern design were installed, the transmission voltage being increased by more than double the old pressure. The line was also re-modelled and the receiving station at Montreal rebuilt, new 22,500 volt cables being laid as part of the work. These modifications were conducted without depriving the power company of the services of the plant. The electrical features of this huge undertaking will be referred to in a subsequent issue.

COMBINED STEAM AND WATER-POWER PLANT.

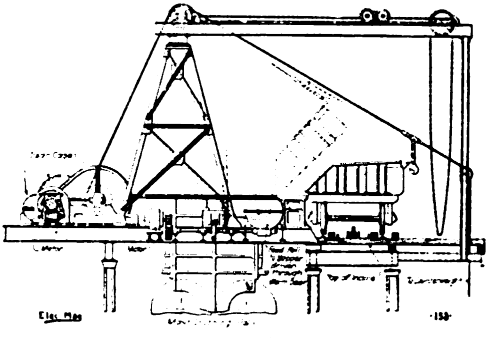
An interesting steam and water driven station is in operation at Richmond, U.S.A., furnishing power to a local railway and lighting in the neighbourhood of Richmond. The city stands about 100 miles from the mouth of the St. James River, where a fall of 25 ft. of water is available for power purposes. The volume, however, varies throughout the year, and from averages made, 8,846 h.p. was obtainable for five months, but only 1,065 h.p. for 11½ months, the minimum being 635 h.p. The load conditions demanded the delivery of 10,000 h.p. continually, consequently the water plant needed augmenting with steam. From the power schedule prepared, the steam engines would stand idle for five months, but for 15 days would supply the entire load. The lay-out of the station is shown in the adjoining diagram, and the designers can be complimented on the score of compactness, if nothing else. The foundations are on bed rock and exceptionally massive. The water wheels, in pairs, are submerged in a wheel chamber, whose arches support the boiler room; the engine house being built over the draft tubes to the tail race. Except for the latter, which are 10½ ft. diameter at the wheel outlet and 14 ft. at the river wall, the space below the engines is filled in solid with concrete. The engines are steeple compound, rated at 750 h.p. each, and coupled to continuous current generators of 700 K.W. At the opposite side of the generator the turbine shaft is bolted up by a flanged coupling. The change from water to steam is effected by uncoupling the connecting rods from the crank pins, while the turbines are disconnected by removing the flange bolts. The change occupies 45 minutes. Seven machines are installed at present, and steam is supplied from four 1,000 h.p. batteries of water tube boilers. The ultimate steam capacity of the plant is 4,000 h.p. An interesting feature is a signal station 50 miles up stream, which telephones the water level at that spot to Richmond, where 12 hours' notice ahead of floods is received and steps can be taken accordingly.



SECTION THROUGH POWER HOUSE.

ELECTRICITY IN CEMENT MANUFACTURE.

At the works of the Edison Portland Cement Co., electrical power is utilised in almost every operation. The plant, designed on novel lines for cement making, operates on a large scale, in conjunction with a quarry, and comprises processes of crushing, weighing, mixing, grinding, calcining, clinker grinding, and coal pulverising, conducted in separate groups of buildings. The grinding and crushing machine is steam driven, the latter handling sizes up to 5 tons, and the former has an output of 280 barrels a day. Some 125 motors are in use, and their employment in atmospheres heavily charged with dust adds another testimony to the many of the adaptability of the electric drive. Power is furnished from a number of isolated plants, laid down to ensure the independence of the buildings. A central power house supplies those motors not connected to the isolated plants, and all such machines can be run up from the station. A third lead for separate excitation accomplishes this, the exciting wire being short-circuited when the motors are at normal speed. A large bank of incandescent lamps provides for the collapse of the fields when stopping. D.C. motors are used and special housings erected with fan circulation to keep out dust. The most prominent electrically driven machines are the roasters 9 ft. diameter by 150 ft. long, with 6 in. motor driven screws. A skip unloading device illustrated herewith, by which three cars are hauled up an incline 250 ft. long to a height of 50 ft., and deliver rock to the crushers, is also driven by motors and controlled by one man. The skips are placed sideways on flat cars and when in position near the crusher, another motor is started, which automatically catches the handle at the side of the skip, lifts it into position, when the rock falls into the hopper. The skip then returns to the car and the hook releases its hold from the handle. The lifting device is counterbalanced by a cube of concrete, hung from the cable to which the hook is attached. The output of the works may be gathered from the capacity of the cement stock-house, which is 100,000 barrels. In the dryer house, one of the dryers has a capacity of 3,000 tons a day, corresponding to 10,000 barrels of the finished product.



ELECTRIC SKIP UNLOADER.

GENERAL POWER NOTES.

Compressed Electricity Works.

In a large business establishment in Berlin, a power plant of 2,400 h.p. has been installed in a remarkably small space. Extensions of the building to accommodate the necessary machinery were found impossible, consequently the engines and generators were installed in the basement, while the boilers were erected under the roof, two floors of lofty sale-rooms dividing the two. Three vertical engines of 230 h.p. each, and two horizontal engines of 700 h.p. each are installed. Six water-tube boilers, fitted with superheaters, 126 deg. supply steam at 150 lbs. per square in. The height of the boilers above the surface level is 56 ft., while a part of the engine-room containing the cylinders of the horizontal engines is only 10 ft. in height. Prof. E. Josse, of the Charlottenburg Technical School, is the designer of the plant.

Practical Points in Three Phase Working.

The Western Electrician in a recent issue contained questions and answers of a practical character on three-phase working. We may quote the first and last of these. How can a mixed load of three-phase light and power be best supplied? By means of four-wire three-phase generators, lights being coupled single-phase between neutral and one of the outsides. The two additional leads for the other two phases can be run out to localities demanding three-phase power. We would like to adopt 5,000 volts, without sub-station transformers, using simply our 5,000 250 volt lighting transformers. Sub-station step-down transformers are not used except in the few cases of very long lines, where the voltage has been stepped-up at the station. The neutral of a three-wire service to every customer should be permanently grounded.

Developments at Niagara.

The capacity of the existing and constructing power plants at Niagara is 675,000 h.p., or 12½%, of the 5,500,000 h.p. available. These figures afford a striking representation of the industrial prospects of Ontario, the Canadian companies developing 375,000 h.p., which will more than meet the demand in that province for some time. The average cost per annum to Ontario consumers is £7 per h.p., which could be delivered from Niagara at a maximum cost of £3, thus affording an annual saving of £600,000. The work of the power companies now in progress will entail an expenditure of about £2,000,000. Among prominent industries which will be beneficially affected, are electro-chemical processes just passing from possibilities to realities. The population within the present city limits is not more than 8,000.

A Scotch Water Power Project.

Blairgowrie and district may probably be supplied with water generated electricity if the prospects of a large firm of electrical engineers come to head. The embankment of Lord Benachally is to be raised 11 ft., and a pipe carried 3½ miles to Butterstone, where an effective fall of 700 ft. would be available. Encouraging surveys have already been made.

Irrigation by Electricity.

Through the agency of electric power, vast plains of sage-brushed desert have been transformed into gorgeous and profitable groves of forest trees. This has been accomplished after numerous experiments with wind-mills and gasolene engines, by transmitting water-generated electric power from the high lands. Energy is supplied through transformers to small pumping stations, utilising induction motors. During three years, upwards of 600 such plants have sprung up, and lands which were previously valueless are now worth £100 an acre. The demand for current has increased to such an extent that one company is installing power plant in the mountains 125 miles to the north of Los Angeles, on the Kern river. Water is pumped from wells sunk at depths ranging from 50 to 1,000 feet below the surface.

"La Houille Blanche."

"Black coal has made modern industry; white coal, will transform it." France, though poor in coal, is rich in water-falls, and in a recent consular report some figures as to the development of the latter for power purposes, are interesting. 48,860 water-falls exist in the Alps, and 46,000 with a total of 489,000 h.p. are in use. In the department of Isère, 37,000 h.p. is utilised. The aggregate horse power in use in France is estimated at 6,780,000, while the mountainous region between the sea, the Rhone and the frontier of Italy, is calculated to yield not less than three million horse power, and five million during eight or nine months of the year. In and around Lyons electricity is utilised in almost every branch of industry. In April, 1903, 12,000 h.p. was furnished to 2,000 subscribers to the Lyonese Power Company.

German Power Plants.

In Germany, according to the annual tables published by the *Elektrotechnische Zeitschrift*, there are 552 power plants and 316,000 K.W. of steam plant. 98 stations depend solely on water, and 196 are mixed steam and water power. Gas driven stations total 61 with 61,000 K.W. output, and there is *one* windmill plant with a load of 450 8-c.p. lamps and a few motors. 738 direct current stations use accumulators and 28 have none. Comparing direct and alternate currents, there are 59 stations, 81,000 K.W., with three phase plants, and 766 direct current stations of 257,000 K.W. output. Single and two phase plants number 45 and amount to 30,000 K.W.

Power Consumers in British Towns.

The users of electric motors in the large towns of this country are rapidly increasing, as returns received from a number of stations show. Glasgow Corporation has 1,059 motors connected to its mains. Birmingham in November last boasted 450 or 1,391 h.p., and Sunderland, with several good customers in shipyards is supplying to two large firms alone upwards of 3,000 units per day. At Sheffield the horse power has increased by 275%, during last year. The consumers increased from 143 to 350 in the period mentioned, and 200 motors are now let out on hire. The improved demand is doubtless due to the use of polyphase motors. At Fulham the h.p. in motors has risen from 40 to 300 since last March.

HOME POWER NOTES.

Power Proposal for Dundee.—A large scheme for an electric power plant at Dundee harbour is under consideration, and the promoters also desire to transmit power to all the city mills.

Yorkshire Power Company Busy.—In addition to pushing forward with its power house, the Yorkshire Electric Power Company is letting contracts for power to colliery owners and manufacturers near Thornhill.

Fife Electric Power Company.—We understand that it has practically been decided to build a power house between the town lock and the West of Fife Mineral Railway, Dunfermline.

Power in the Rossendale Valley.—The Lancashire Electric Power Company has completed its arrangements for supplying electricity, in bulk, in north-east Lancashire, including the Rossendale Valley.

Electric Bascule Bridge.—The Bascule Bridge carrying the Barking and Beckton tramway over the Roding is operated by two 33 h p. motors, supplied from the traction mains. An electric locking device prevents the raising of the bridge when a car is crossing it.

FOREIGN ITEMS.

Motive Power in Pretoria. — The Pretoria Town Council have recently been enquiring into the amount of horse power used by the various steam plants in the city, with a view to eventually displacing these by electric motors. In this proposal a good opportunity is presented to motor makers.

Hudson River Power.—Spier Falls will shortly yield 32,000 h.p. to Albany, Troy, Schenectady, and many smaller places. Ten pairs of turbines are used, with a head of eighty feet.

A Norwegian Power Plant.—5,500 h.p. of plant has recently been installed 23 miles from Drammen, Norway, energy being transmitted at 25,000 volts.

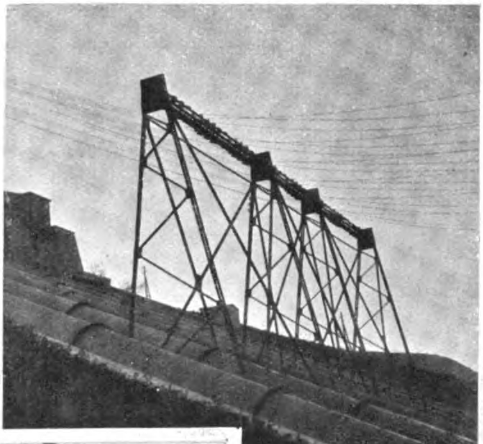
Motive Power at Redfern.—We learn from our Sidney correspondent that motors are rapidly replacing steam-engines at Redfern, N.S.W., the electric lighting plant being extended to meet the demand for motive power.

Electricity in a Food Factory.—The Natural Food Company, of Niagara Falls, operates all its machinery by electric motors, power being taken from the Niagara Falls Power Company. The transformer installation has a capacity of 2,200 K W.

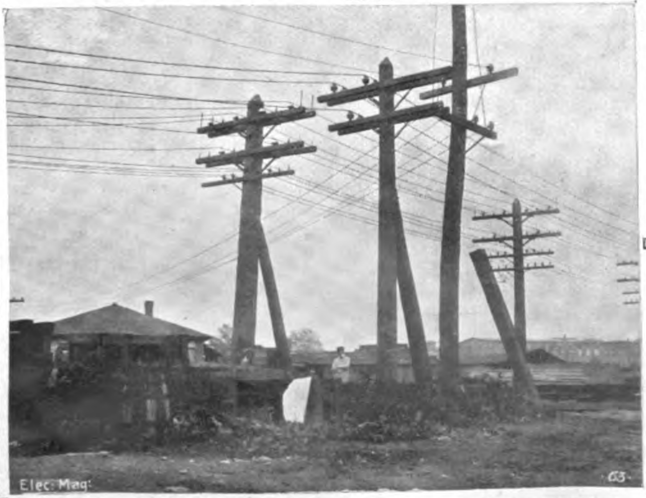
* * *

A COMPARISON.

An English engineer sends us the photographs reproduced herewith ,and comments very strongly on the almost English thoroughness of the workmanship of the overhead work of the Padermo-Milan High Pressure Transmission line (shown on the right), as compared with the temporary and apparently careless nature of the American parallel at Niagara (shown on the left).



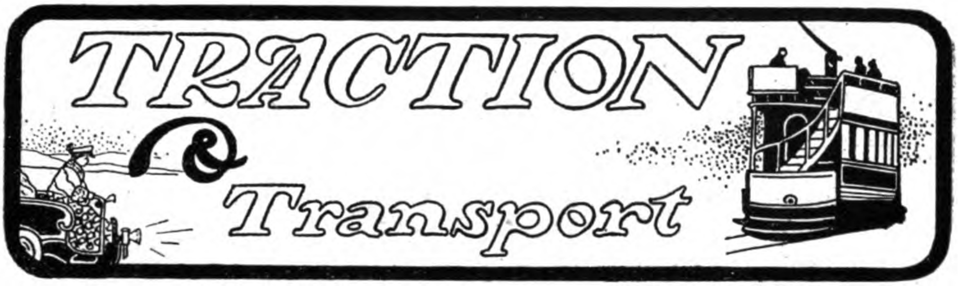
Padermo-Milan Lines.



Niagara Falls Lines.

Fire at Johannesburg.—Eight single-phase alternators were partially destroyed by fire at Johannesburg Electricity Works recently: the three-phase plant was not injured.

Riva Power Plant.—Riva, on Garda Lake, Tyrol, has only a population of 8,000, but is supplied with electrical energy from a 2,000 h.p. water plant.



The extraordinary and rapid developments in electric traction call for a special section entirely devcted to this work. The main systems in vogue or projected in every country will be specifically considered. and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

ELECTRIC TRACTION FOR RAILWAYS.

II. The Coming of One-phase Methods.

By W. M. MORDEY, M.Inst.C.E., M.I.E.E.

(Continued from page 46).

In the previous article some reasons were very briefly given for the belief that a satisfactory solution of the problem of electric traction for railways cannot be looked for from either of the methods at present in use, nor from any combination of them—those methods being, first, the ordinary direct-current system as used here, in America, and on the Continent, with or without high tension alternate-current generating and transmitting arrangements; and, second, the three-phase alternate-current method as used on a number of lines on the Continent. If it were a question of the survival of the fitter of these two, then the inherent drawbacks of direct-current methods would ultimately give the victory to the multiphase; but the probability—in the author's opinion, the certainty—is that both will give way to one-phase methods.

Since this belief was expressed two years ago, substantial steps have been taken towards the realisation of this belief. At that time no trials had been made—there was no one-phase motor in existence capable of exerting the necessary starting effort—and there was only one practical way in sight by which a train could have been driven by one-phase, that was by a motor-generator carried on the train, as proposed years ago by Ward-Leonard—an interesting method, to which further reference will be made later. Since then one-phase motors have been so improved, that, weight for weight, they exert as great a starting torque as direct-current traction motors. This has helped the matter forward by making it possible to use one-phase motors very much in the same way as direct-current motors have been used, with very little change from existing arrangements.

Before referring to the first practical steps that are now being taken to work out this problem, it may be useful to glance at the position of one-phase alternate-current as applied to lighting and power, for that is the field in which the preparatory work has been done for electric railways. Alternate-current electric lighting started with the one-phase system, and, at the present time, probably

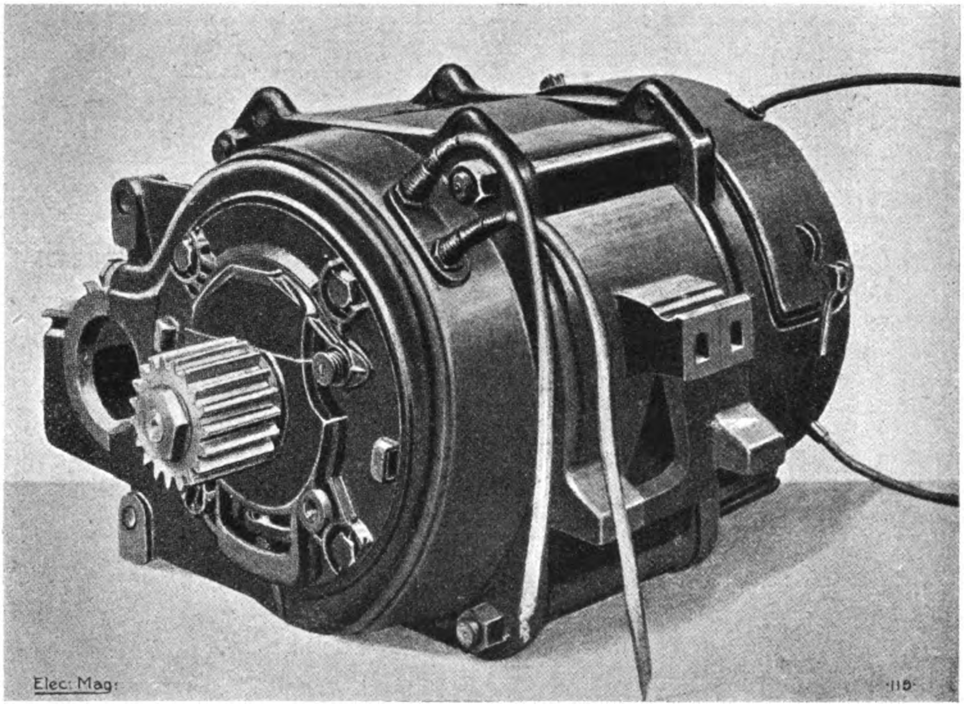


FIG. 1. WINTER-EICHBERG MOTOR.

a larger amount of lighting work is being done by that system than by the later two-phase and three-phase methods.

For power purposes, however, the one-phase system was found to be at a disadvantage as compared with two-phase and three-phase, because the latter enabled motors to be used which had better starting qualities—not because those systems had any advantage for lighting; on the contrary, they were worse for that—the additional phases were provided merely to give motors better starting qualities. If we can get those starting qualities by the simpler one-phase method, then it will gradually come into greater use for lighting and power, and multiphase will be used only for certain special cases, reference to which is outside of our present purpose. It may be said that for lighting and for ordinary power work, given good starting, the fewer the phases the better; while for railways, where the simplicity of the line arrangements is of vital importance, more than one phase is out of the question, except, as has already been said, as a makeshift.

In this place it should not be necessary to say that there is no justification for the very common belief that the one-phase alternate-current system is entirely unsuited to cases where power is required. That impression is as deep-rooted as the popular belief that the weather changes with the so-called changes of the moon. That neither personal experience nor the meteorological records lend any support to this latter belief makes no difference. So with one-phase and power. In spite of the fact that one-phase motors, aggregating very many thousands of horse-power, are in daily use—one town alone having six or seven thousand horse-power of them connected to its mains—the belief in their non-existence is very general, and is not confined to people unconnected with electrical engineering.

It is interesting to note, that already the developments of one-phase motors have placed them ahead of two or three-phase motors in one respect, which is important for many engineering applications, apart from traction, namely, the power to vary speed efficiently through fairly wide limits. In this respect, direct-current motors have always been better than multiphase motors, but now, one-phase motors can claim to be better than either.

It is perhaps a little early to say that the improvements in one-phase motors will enable one-phase to take the place of multiphase in general distribution—it is early, because, so far, these improvements have been made in motors working at lower periodicities than are necessary or desirable for lighting; but the author has little doubt that what is now true for low period traction motors will before very long be true also of motors working at forty or fifty periods a second. Restrictions on this score exist equally with one-phase and with two or three-phase, the latest railway equipped with the latter having a periodicity too low for lighting.

The advantages of the one-phase method for railway working are so great, that even if motors capable of exerting a large starting effort were not available, that method would in time come into use, but now that large starting effort has been added to its other qualities, progress will probably be rapid. Large starting effort, however, is not everything. Successful railway working requires a combination of many things, of which large starting effort in the motors is one; simplicity of line is another; and, for some conditions, great importance must be attached to variable ratio in regulation and to the ability to return energy to the line when stopping or "coasting," instead of wasting it in heating the brakes.

As regards good starting effort for a given weight, direct current motors possess this quality, but only at a great sacrifice in other parts of the system. When supplied on the constant pressure system—the only practical system, whether for direct or alternate-currents—the starting conditions are so bad that, at the moment of starting, two-thirds of the power delivered to the train is lost before it gets to the motors. Thus the plant at the generating station must be large enough to provide for this loss, and the transmission line must be increased on the same account. The lightness of the motor might be sacrificed without regret if some of this loss could be avoided. A good deal of it can be avoided with alternate currents, and while it will be evident that mere lightness may easily be over-valued, it is very satisfactory, and very important, to find the progress that has been made in this respect with one-phase motors. So far as starting effort is concerned, they are now practically equal, weight for weight, with direct-current motors, while they enable variable ratio arrangements to be made which will reduce the sacrifice of power at starting, and so lower the "peaks" on the load curve. This will not perhaps greatly affect the output of the generating plant in units, but it will reduce the amount of plant required.

The practical application of one-phase motors for traction on railways is now being studied in many directions, by the Union Co. in Berlin, by the Oerlikon Co. in Switzerland, by Finzi in Italy, and in the United States by the Westinghouse Co. and by Arnold—and by others. The

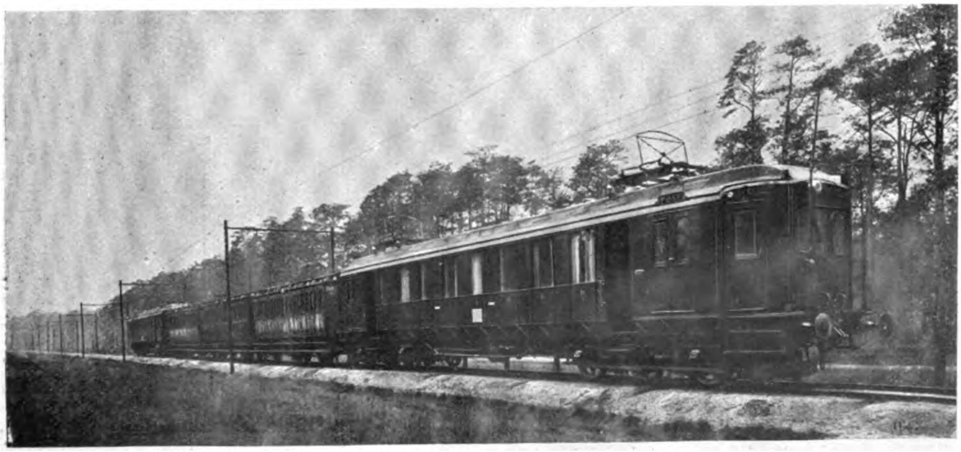


Fig. 2. Train Fitted with Winter-Eichberg Single-Phase Motors.

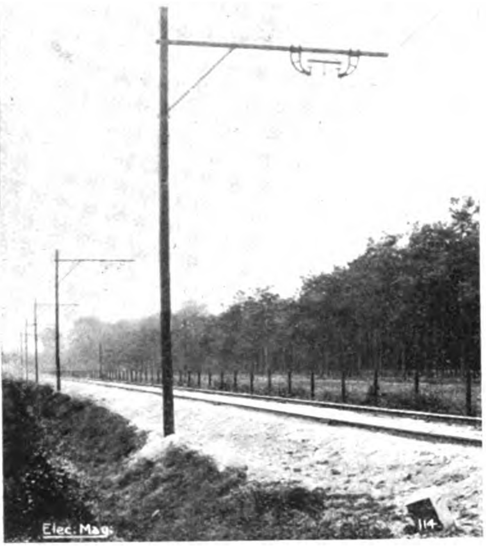


FIG. 3. OVERHEAD LINE.

first practical demonstration of this method on a railway seems to be that of the Union Co. (the Union Elektricitats Gesellschaft, of Berlin, which is now associated with the great German company, the Allgemeine Electricitats Gesellschaft). This Company has equipped a length of railway between Johannisthal and Spindlersfeld, near Berlin, on which it has run a train using the Eichberg-Winter one-phase motors. It is significant that this work has been done by those who have been associated with the famous three-phase high speed railway experiments on the Marienfeld-Zossen line, where speeds of 130 miles an hour were attained.

It will be seen from Fig. 1 that the Winter-Eichberg motor is very similar in appearance to an ordinary direct-current traction motor.

The whole train is illustrated by Fig. 2, while the overhead conductor is shown more clearly in Fig. 3. The conductor is arranged in the same way as the ordinary trolley line of an electric tramway, with a slightly modified suspension to suit the higher speed. The aim on this line has not been to develop great power or speed, but rather to show that an ordinary train could be driven at an ordinary speed with a very simple line equipment and equally simple driving arrangements. This object would appear to have been successfully achieved.

The principle will be understood from the following explanation. The arrangement of the motor is shown diagrammatically in Figs. 4 and 5. In its general arrangement the motor resembles a direct current motor, the armature B being wound with an ordinary direct-current winding (b) and provided with a commutator exactly similar to that of a direct-current armature. The stator or field magnet A is built up of iron sheets, and has a one-phase pole winding (a) embedded in half-closed slots. There are two pairs of brushes—one pair C.D. is short-circuited, the other pair E.F. is placed on the commutator at right angles to C.D. The connections are such that by way of the brushes E.F. the armature winding (b) is put in series with the stator winding (a). This is as shown in Fig. 4, but for purposes of regulation the armature receives its current from the secondary (S) of a transformer, the primary (P) of which is in series with the stator winding as shown in Fig. 5.

The transformer secondary is provided with a number of terminals which enable the pressure applied to the rotor to be varied, thus giving a means of regulation through wide limits without the necessity for wasteful resistances. It serves another very useful purpose in enabling a low pressure armature winding to be used, however high the pressure of the line may be. Thus, although there is a commutator just like a direct-current commutator, the difficulties connected with commutation at a high pressure are avoided.

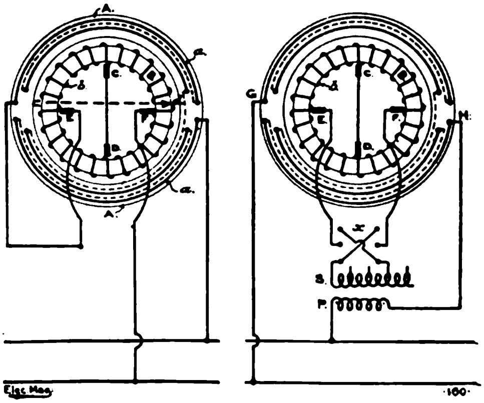


FIG. 4. FIG. 5.
DIAGRAMS OF WINTER EICHBERG ONE PHASE MOTOR

The current flowing into the rotor, by way of the brushes EF, sets up a magnetic field (alternating) in the direction of the arrow *cd*. The same current, flowing into the stator, sets up a magnetic field (alternating) in a direction at right angles to the arrow *cd*. Both these fields are in phase with the current. Except that the two fields are alternating instead of direct, the conditions, so far, are exactly the same as in a direct current motor, and rotation takes place in the same way. But there is another effect. The stator produces an E.M.F. in the armature winding, which sums up between the brushes CD, and as these brushes are short-circuited, an induced current consequently flows through the armature winding. In other words, the armature winding forms a closed secondary circuit to the stator winding, which is the primary, and so the impedance of the stator is reduced. In addition, this secondary current in the armature winding, in combination with the transverse field, in the direction *cd* (set up by the impressed armature current, flowing through the armature by way of the brushes EF) causes a torque in the same direction as that due to the latter current.

The secondary E.M.F. in the short-circuited rotor winding is the same for any given flux and armature current, whether the rotor is standing or running. When running there is an E.M.F. between C and D due to the motion in the magnetic field, but that E.M.F. is in two equal and opposite directions in each half of the armature, so that they do not affect the total E.M.F between C and D. The short-circuit current, by increasing the power-factor, allows more current to enter the motor than would otherwise be the case, and so the torque is increased. As the speed rises, the back E.M.F. rises also in the direction between the brushes EF, and if the applied pressure is correspondingly varied, the motor is enabled to exert the required power.

In practice, for purposes of such control and to keep down the E.M.F. in the rotor winding, the latter is not put directly in series with the stator winding (as shown in Fig. 4), but is supplied from a transformer as explained above, and as shown in Fig. 5.

The variation of the pressure applied to the armature by this variable-ratio transformer corresponds in effect to the variation of pressure applied to a direct-current motor by adjustment of resistances in the circuit; but it is accomplished without the waste of energy inseparable from the use of such resistances.

Reversal of the direction of running is obtained precisely as in a direct-current series motor, by reversing the direction of the current in either the armature or the field. A switch *(x)* for this purpose on the secondary of the transformer is shown in Fig. 5.

It will thus be seen that this motor may be regarded as working in a very similar manner to an ordinary direct-current traction motor, but with an added effect due to the re-action between the secondary or induced current, and the transverse magnetic field set up by the impressed armature current.

This explanation is necessarily a very brief one; it aims only at giving a general idea of the action of this motor, and does not attempt to fill in details of such action. It should, however, be said, in fairness to the makers of the motor, that this explanation of the action is not in the least like the one they have furnished.

(To be continued.)

W. M. Mordey.

[Mr. Mordey, in next month's instalment will deal with further interesting single-phase systems, which will be depicted by unique illustrations.]

SINGLE PHASE TRACTION.

The amount of attention now being devoted by many engineers to the problem of single phase traction, was referred to in the opening address to this section, and one of its most prominent advocates is now dealing with the question in our columns. Two important contributions to this subject appeared in the December issues of our contemporary, *The Electrical World and Engineer*, from Mr. P. M. Lincoln and Mr. B. G. Lamme, respectively. The former writer summarises succinctly, but very completely, the pros and cons for alternating *versus* direct-current for the purposes of electric traction. He then gives in parallel columns, a complete series of estimates for the construction and working of a typical road on the direct-current and alternating current systems respectively. The road is assumed to have a length of 60 miles, with a schedule speed of 30 miles an hour, and stops of 30 seconds each at intervals of two miles. The weight of the direct-current car, with equipment, is taken at 35 tons, and that of the alternate-current car at 41·3 tons. A considerable portion of the 18 per cent. increase in weight allowed for the alternate current car is due to an induction regulation being estimated for, as the author considers that its advantages more than compensate for the increased weight involved. The acceleration is taken at a mile per hour per second, and the braking acceleration as twice this. The high pressure line is assumed to have a voltage of 20,000 in each case, three-phase for the direct-current system, and single-phase for the other. The results of the comparison very decidedly favour the single-phase system, but for the actual figures we must refer our readers to the original paper. The conclusions of Mr. Lincoln are of exceptional interest and importance, as they may be assumed to embody, more or less, those of the two great companies which mainly control the manufacturing side of the electric railway and tramway industry in the United States.

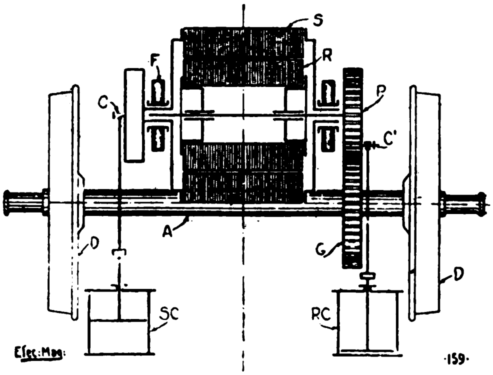
Mr. Lamme's interesting paper deals very fully with the principles of the commutator type of single-phase motor, with a detailed comparison of the various losses occurring in this type of motor, with the corresponding ones in the direct-current series railway motor. Many attempts have been made during the last ten or twelve years to construct alternate-current commutator motors. Until quite recently these attempts have all been unsuccessful, owing to excessive sparking at the commutator, so that it had almost become a fixed belief with the majority of electrical engineers that this difficulty was, in some mysterious manner, due to inherent properties of the alternating-current, and therefore insuperable. Recent advances in our knowledge of the theory of commutation have quite exploded this fallacy, and have shown how the special difficulties met with in the commutation of alternate-current motors may be overcome. These difficulties are due, in the main, to eddy currents in the coils short-circuited by the brushes.

The author advocates the use of low voltage motors, with a transformer on the car, in order to obviate the otherwise heavy insulation which would be required to ensure immunity against breakdowns.

◆

THE ARNOLD ELECTRO-PNEUMATIC RAILWAY.

A FIRE in the car shed of the Lansing, St. John's, and St. Louis Electric Railway, on which have been made the experimental trials of B. T. Arnold's electro-pneumatic railway system (referred to in the opening address to this section), has, unfortunately, destroyed the experimental locomotive and the two new motor cars which had been constructed for further trials. The further trial of the system, which was to have been made early in January, has, therefore, had to be postponed, and the inventor has, consequently, furnished the American technical press with a very complete account of the work done. We are able to give an illustration of his single-phase motor, which runs at constant speed and constant load, and, therefore, at maximum efficiency. Speed control, including starting and stopping, is effected by retarding or accelerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that a portion of the energy usually dissipated through resistances is stored to assist in starting the car, helping over grades, for use in switching, and for the operation of the brakes.

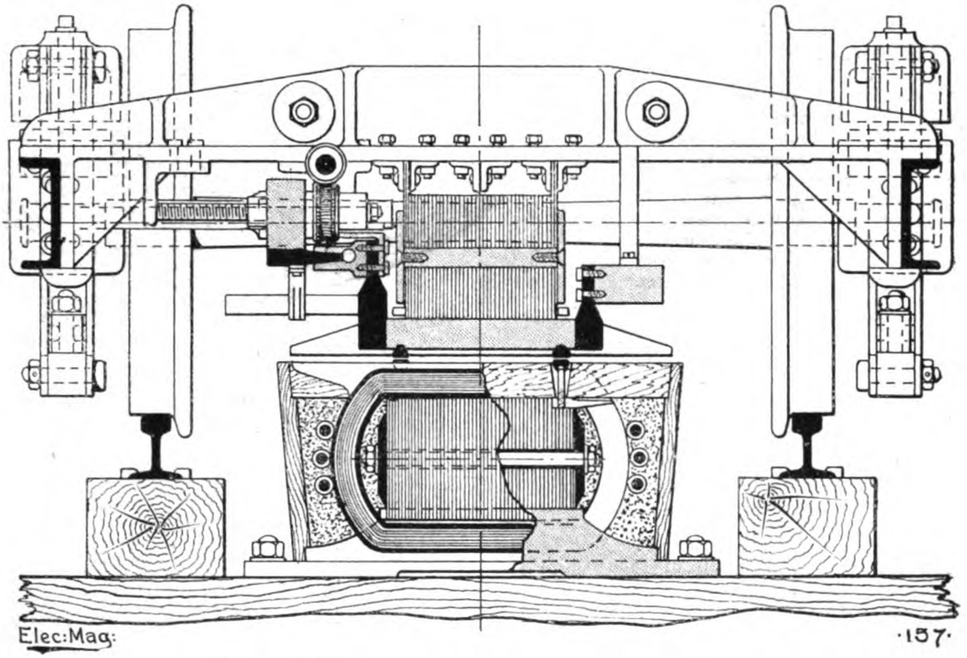


ELECTRO-PNEUMATIC RAILWAY. DIAGRAM OF MOTOR AND COMPRESSORS.

◆

TANGENTIAL TRACTION.

WE are able to give our readers this month an illustration showing the construction and arrangement of the travelling field motor employed in Messrs. Rosenfeld and Zelenay's system of tangential traction referred to in the introductory address to this section in last month's issue. It is taken from a paper by the inventors in the Bulletin of the Institut Montefiore. The illustration shows very clearly the construction of the stator sections, which are fixed to the road-bed, and also of the "propellor," which replaces the rotor of an ordinary three-phase motor. The experimental car, the under frame of which is shown in the illustration, weighs 22 tons, and runs on an experimental line 800 metres in length, which has been laid down at Charleroi under the supervision of M. Dulait, the General Manager of the Cie Electricité et Hydraulique. At the present time, the length of line occupied by stator windings has been brought down to one-twentieth of the whole. Numerous practical difficulties have been encountered, and successfully overcome, during the considerable period over which the experimental work has extended. The most serious of these was the largeness of the air-gaps between the two portions of the motor. The inventors state in their paper that this cannot be reduced below 10 mm., and if our latest information is correct, it has been found necessary in practice to increase this by something like 50 per cent. We understand that, by an ingenious



TANGENTIAL TRACTION. SECTION THROUGH TRACK AND TRUCK.

method of winding, details of which have not yet been published, the inventors have succeeded in reducing the lag which would ordinarily result from so large a gap, to an extent enabling it to compare with that of the usual polyphase motor. The switches employed to make each section alive as the car enters it are operated by small low-voltage three-phase motors, the stator circuits of which are permanently closed. As the car leaves a section, the switch is opened automatically by means of a counterweight. Details of cost, though promised shortly, are not yet available, so that the basis is wanting at present for forming an opinion on the commercial practicability of the system. All that we can say at present with regard to this point is that some at least of those who are financing the experimental work are engineers of extensive commercial experience, who do not usually spend large amounts on experiments without a fair prospect of a return.

◆ ◆

TRACTION NOTES.

◆

Breaking of Trolley Wires.

THE breakage of a trolley wire on the Nottingham tramway system, during the last week of the old year, and a similar occurence at Brentford, in the first month of the new year, and other recent occurrences of a similar character, afford instances of a type of accident which is fortunately not very frequent, but which, if it does occur, must inevitably give rise to considerable trouble and annoyance, even if it cause no hurt to man or beast. This was happily the case at Nottingham, but at Brentford, one of the wires fell on two horses and killed them. Guard wires are required by the Board of Trade regulations, where telegraph or telephone wires cross over the trolley wires, and various so-called safety devices have been proposed for the purpose of preventing contacts of this kind. The provision of guard wires, however, on a sufficient scale to eliminate all possibility of accidents from the breakage of trolley wires, would be prohibitively expensive, and a great desideratum at the present time is the discovery of some material for trolley wires with sufficiently high tensile strength and resistance to abrasion by the trolleys, to minimise the likelihood of breakage. In the meantime, it would be quite feasible to provide against a fallen trolley wire remaining alive by the use of a device which would earth the wire at the two poles between which the break occurs. A simple and efficient device of this kind was adopted on the experimental high-speed railway line between Zossen and Marienfelde. A loop of 8 mm. copper wire is clamped at each point of support of the trolley wire, in such a manner that, if the latter should break between two poles, the trolley wire would be earthed at each pole, by the loop being drawn against a copper wire having its lower end connected with the rails, and terminating above in a spring attached to the pole.

High Speed Railroading.

IT is often assumed that the results obtained on the Zossen-Marienfelde experimental line have demonstrated the feasibility of running at similar high speeds on sections of ordinary well-constructed permanent way, provided the curves on the sections selected are of sufficiently large radius. It should be borne in mind that the experimental line referred to, in addition to having the road-bed strengthened and heavier rails laid, so as to bring it nearer to our standard main line construction, was provided throughout (at great expense) with inner guard rails carried by heavy iron cross-pieces, one of which was fixed to every sleeper. We are informed, moreover, that observations made by a eminent engineer who participated in the recent trials, showed that, notwithstanding the straightness of the line, these guard rails were frequently touched by the wheels, from which it was to be inferred that they were requisite to ensure safety at the high speeds attained.

Electricity on the Manhattan Railway.

EXCELLENT results are shown in the annual report of the Manhattan Elevated Railway Co. of New York City, upon the adoption of electricity in place of steam on their railway system. For the past six or eight months the system has been worked by the Manhattan Railway division of the Interborough Rapid Transit Co. The gross earnings of the old Co. for six months ending March 31st, 1903, were $6,441,437, operating expenses $2,819,764, and nett earnings $3,621,673. A combination of the reports of the old Manhattan Co., and the Rapid Transit Co. for twelve months ending Sep. 30th, 1903, shows that gross earnings of the former increased by $1,584,231, and operating expenses decreased $115,921, the nett earnings increasing also to the extent of $100,7,152. The balance after paying interest and taxes increased $1,397,736, and was brought up to $4,723,798, being equal to about 8½% on the entire $55,200,000 capital stock of the Co., as compared with 6.9% on $48,000,000 stock in 1902. The Rapid Transit Co.'s report for passengers carried the last six months showed an increase of $17,384,556 on the corresponding period last year. The operating expenses for the period mentioned were 42% as compared with 51% last year, when the trains were drawn by steam locomotives. For the quarter ending July 1st, 66,105,436 passengers were carried, while for the corresponding period last year 57, 699,243 passengers were carried. In addition the increased speed of the trains has been of special advantage to all users of the railway. The wages of the employees have also been increased during the year and their hours of work cut down.

Trolley Omnibus Experiments, U.S.A.

IN spite of the notoriously rough state of American roads, a condition accounting for the almost general employment of the trolley car in that country, matters are not too serious to prevent the use of the trolley omnibus, now familiar to several districts on the continent, and shortly to be put on some of our own roads. Experiments at present being conducted at Scranton, Pa., with a trolley omnibus of the automobile type, present some interesting figures. Two wires are used for the overhead system, though three can be employed, and a switch, necessary at loops with two wires, is thereby avoided. A movement of the vehicle of 15 feet to either side of the wire is possible, so that it can be handled almost as if it were unattached. Sharp curves can also be successfully negotiated. Trolley wires and supports are put at about £340 per mile, and a coach with motor and trolleys complete, for 20 seated passengers and 15 standing, would cost about £540.

TRACTION NOTES IN BRIEF.

Electric Traction, by J. H. Rider.—A review of this book, one of the latest additions to the literature on the subject, will be found in our Review section this month.

Note of Approval.—Mr. Lamme's paper on single-phase traction motors, says *The Electrical World and Engineer*, in a recent editorial, "is a clean, sane note of common sense, rising above the babel of discordant equations, which has made alternating motor practice a region of horror to the ordinary man."

Paris Railway Traction.—The Railway des Invalides from Versailles to Paris, employs high tension three-phase current, transmitted through underground cables to three sub-stations, provided with transformers and synchronous converters. The installation was described recently in *L'Eclairage Electrique*.

Trolley *versus* ***Third Rail.***—The relative merits of third rail and trolley for high speed roads were discussed in the *Street Railway Journal* recently. Where trolley wheels run from 5 000 ot 10,000 miles on a heavy interurban car, it is assumed that this is the most satisfactory method of obtaining current.

Australian Electric Railroads.—A recent report from Mr. A. G. Pendleton, Chief Railway Commissioner, deals with the possibility of electrifying the suburban railways of Adelaide, South Australia. Estimates are given, and altogether there would seem to be excellent prospects of the scheme developing into practical shape.

Antwerp Trams.—Until the year 1899 horse trams in Antwerp were controlled by seven companies, but a consolidation took place at that time, and steps were taken to introduce electric traction, powers being obtained late in 1902. In March of the same year the work had begun, and was so vigorously pushed forward that the 31 miles of track have now been converted.

Single-Phase Traction with Speed Regulation.—In the *Elektrotechnische Zeitschrift*, Mons. Latour says that three types of commutator motors are suitable for single-phase traction, all three permitting of perfect operation near synchronism. First, the repulsion motor, with stator winding distributing in slots; second, the shunt motor without phase difference, which starts as a repulsion motor; third, the series motor without phase difference.

Electric Traction on Canals.—With reference to our note on this subject last month, an article in *Elek. Zeit.*, Dec. 31st, describing trials on the Tetlow Canal, Germany, is of interest. A locomotive, supplied at 550 volts, hauled loads up to 1,450 tons at an average speed of 4·35 km. per hour. Haulage through tunnels was undertaken by an electric boat carrying accumulators, and exerting 20 h p. with the motor at 600 revolutions. Two vessels, representing 4·54 tons, can be dragged by this boat.

Multiple Unit Systems.—Referring to our introductory address to this section last month, we are asked by the British Thomson-Houston Co to state that their system of multiple unit train control is in use on the Central London, Great Northern and City, and the Harrow branch of the Metropolitan District Railways, and will also be used on all the lines of the Underground Electric Railway Company of London, Limited. The Westinghouse Electro-Pneumatic system, we may state, is to be used on the London Metropolitan Railway when converted.

From Cable to Electric Traction.—The *Street Railway Journal*, in a recent issue, gave an illustrated description of the conversion from cable to electric traction in St. Louis. A large business is done on the line, and the change was effected without interfering with the traffic. A 9 inch girder rail was first set about 6 inches outside the cable rail; the paving and old cable slots were then removed, the top of the cable yokes were broken off, and a 6 inch rail for the electric track mounted on the inside of the cable yoke. The old conduit was filled with broken stone, and temporary connections made between the old and new construction.

Notable Recent Papers.—A number of important papers on electric traction, both for railways and tramways, have been read during the past month. Mr. McMahon's paper on "The Working Results of the City and South London Railway," evoked an interesting discussion, during which no one questioned the method of distribution as in any way inferior to the polyphase system with rotary converters. The reconstruction of the South London Tramways formed the subject of an interesting paper, by Mr. A. Millar, before the Inst. C.E., on January 12th. Mr. A. C. Eborall dealt with electric traction with A.C. currents before the Manchester Inst. E.E., on December 15th.

LIGHTING and Heating

Under this heading the development of lighting and heating by electricity will receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., will be comprehensively and impartially described and illustrated.

The Cost of Street Lighting.

By W. H. STORY, M.A.

THE charge for street lighting is well known to be a very variable quantity. In some places, it is said to be done below cost price, and here is of course to be seen the result of municipal enterprise. Whether this is as it should be is not the precise point; the real thing is to find out what it actually costs, if done on ordinary commercial principles. The various municipal stations do not here afford the best ground for studying the question; partly because of the theory that the ratepayers in general should have something in return for their risk, and this something is most conveniently given in the shape of the lighting of the public streets at the expense, to some extent, of the private consumer; partly, also, because the accounts of a municipal concern are always very involved, and it is not easy to separate any particular item with great certainty; partly, again, because, even in cases where the thing is not supposed to be done below cost price, there is no great agreement as to the principle on which the charge should be made. A fair test is probably made best in those cases where the streets are lighted by a company, admittedly for profit on ordinary business principles. Such a case is seen at Westminster, where the streets are lighted by various companies, by gas and electricity. Here, if anywhere, one would think is a chance of settling the problem once and for all, in so far as big towns are concerned. All the elements of competition seem to be there. There is gas competing with electricity, well knowing that valuable contracts are to be given away as the result. Moreover the electrical contracts are divided between three different companies. And yet one can hardly say that all the recorded figures point in one direction. The Surveyor to the Westminster Council has from time to time issued reports on the results of his observations on the street lighting of his district. Amongst others, a contract has been entered into with the Westminster Electric Supply Corporation for thirty years, whereby they will supply and maintain about 1,000 arc lamps, besides a smaller number of incandescent lamps. The number will probably be increased in the near future. The price to be paid is £32 per annum for a 750 watt arc lamp, £22 per annum for a 500 watt arc lamp, £4 for a 120 watt incandescent lamp, and £3 for a 60 watt lamp. These prices are to be subject to a cumulative rebate of ½ per cent. per annum for each year after the first. The charges would seem to be such as to admit of profit, but under the circumstances we should imagine that the profit is only enough to cover commercial risk and provide interest on capital, seeing that the company have to supply and maintain all lamps, posts, cables, etc. Professor Kennedy, who no doubt largely decided the price at which the Westminster Company would be willing to undertake the work, has had extended experience in connection with a similar problem on a similar scale in Edinburgh; but in this case, things are complicated, as aforesaid, by the fact that the municipality is doing its own lighting. Still, there the price has fallen steadily from the start with the gradual extension of the system. Originally the charge for an arc lamp was about £22, and has now fallen by about 33 per cent. As regards Westminster, other contracts have been entered into with the Charing Cross Company, and with the St. James' and Pall Mall Company. Curiously enough, the prices and conditions differ in all these cases. The most notable variation in the conditions is the length of time over which the contract definitely extends, and as both of these latter contracts are terminable after seven years, the price to be paid is, as might be expected, rather higher. The charges for a 500 watt arc lamp in these cases, without allowing for interest on capital, outlay for mains, lamps, etc., are in one case £28, and in the other £30. The Surveyor does not appear to have considered that his work was done when these contracts were concluded. He has since possessed himself of an instrument which is described as a portable photometer; but judging from the illustration of the apparatus, which is shown housed on a kind of perambulator, it can only be said to be portable in the limited sense in which that adjective might be applied to the Encyclopædia Britannica. With this instrument he has examined periodically at unstated intervals a large number of his lamps, both gas and electric. The results show that, when account is taken of the light produced, the electric arc may pride itself on being twice as cheap as the Welsbach mantle, if the prices at which lighting is done in Westminster can be taken as correct estimates of the rates at which work of this kind can be profitably undertaken. The price of coal does not probably largely affect the ratio of the cost of gas to that of electricity. It is perhaps unwise to generalise too hastily on an insufficient number of facts. Possibly the impartial critic might point out that even in the figures supplied by the Westminster Surveyor there appear to be a not inconsiderable number of peculiarities which should give the hasty theorist something over which to ponder. Thus it may be admitted that it seems that the Westminster Company only receives one half of what is paid to the St. James' Company for the supply of one candle power for an hour. On the other hand, six Welsbach burners in Carlton House Terrace cost about half as much again as six in Victoria Street, having regard to the light emitted; but this must probably be put down to the infirmities of old age in some of the burners examined. Age is a matter of vital importance with Welsbach burners. The light falls off steadily from the start, until, as the report pathetically observes, they become too dull to test. Still, there seems every reason to be satisfied that the arc lamp is a far more efficient illuminant for street purposes, provided the light is required in large units. Sugg's high pressure incandescent mantles show, however, results nearly as good; but such results are only obtained when the mantles are in good condition, and the hydraulic pressure gear is working. But these lamps too are worked in large units, and consequently appear to possess no advantage over the arc lamp. The real advantage of the Welsbach mantle for street lighting lies in the fact that it is economical even though the light emitted is not necessarily large in amount. Herein lies a large field for the Nernst lamp. If it can be applied to street lighting without any ground glass bulb, it might meet the Welsbach mantle on its own ground without fear of consequences.

A NOVEL ILLUMINATED FOUNTAIN.

ELECTRIC lights have long played a prominent part in spectacular effects, and though no radical changes have resulted from many years' experience, still elaboration to a highly artistic degree is to be recorded in some instances. An example is to be seen in the illuminated fountain illustrated opposite, which has several striking features above the common ken of such devices.

The falling water in this case is illuminated from within, and not from without, as is usually attempted, and the effect produced is a striking monument to the application of the electric glow lamp for exhibition purposes. The water, delivered to the fountain through a central hollow stem, is distributed over the surface of a dome-shaped crown, and, leaving the edge of this, descends in the form of a hollow cylinder into the ornamental cistern below. Inside the "water tube" a large number of glow lamps of various hues are artistically arranged, and beautiful effects are obtained by the rays playing on and through the water. The fountain is about 14 ft. high, and deals with 300 gallons of water, circulated at the rate of 1,000 gallons per minute by an electrically driven pump.

It has been constructed by Messrs. Keith and Blackman, and erected in the Pompeïain Court of the Crystal Palace, where its novelty has secured it considerable comment. In addition to proving an attraction, it serves the purposes of a powerful illuminant (about 5,000 c.p.) and a cleanser of the surrounding atmosphere. By the use of electric fans concealed in the stem of the fountain, air is drawn into contact with the falling water, which removes all solid particles from it, and the cool, purified air is expelled into the body of the building. The principle of the device can be applied, on a smaller scale than that illustrated, to hotels, theatres, cafés, etc., with equally efficient results. The combined employment of glow lamps and motors in the construction of this interesting design opens up a new field of possibilities for electricity in pleasure resorts.

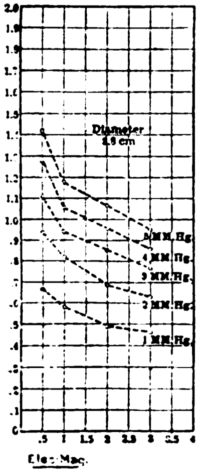
A NOVEL ILLUMINATED FOUNTAIN. *(See page 170).*

THE LIFE AND EFFICIENCY OF THE NERNST LAMP.

A GREAT deal has been published from time to time bearing on the Nernst lamp, and curves showing all its peculiarities as dependent on change of voltage, etc., have been embodied in various papers. There has, however, always been a tendency to shirk the question of the life of the lamp, and the results obtained in the rough way of putting the lamp in a socket, fed with current from a supply company's mains, have been of such a divergent nature that little seems definitely known. The German lamps, which will be used in this country, have their own peculiarities; the American lamps, with which we shall remain unacquainted for many years to come, interest us only on paper, but have none the less a well marked individuality. Of the lamps that have been tested by various people in England, some have burnt out almost at once, others have lasted 500 hours and more, though observers report there are more of the former variety than should be expected. It is therefore a matter of interest to examine the tests on the lamp which have been made by the Reichsanstalt at Charlottenburg, seeing that this institution can be regarded in the light of an impartial expert. In a paper recently read by Herr Oskar Bussmann, the figures of these tests are given together with others which were the result of the work of Professor Wedding. Taking first lamps consuming one ampere at 220 volts, the Reichsanstalt examined six of these, and Professor Wedding another six. The average life obtained by the two sets of tests was very different. The Reichsanstalt say that the mean life was 286 hours, while Wedding says in his tests it worked out at 538 hours. So in this particular we have a great divergence of results. With regard to efficiency there is a nearer approach to agreement. The mean candle power is stated by the Reichsanstalt to have been 139·1 (1 Hefner candle is equivalent to 0·88 British candle power); and the average consumption is 1·63 watts per Hefner candle power, *i.e.*, 1·85 watts per British candle power. The figures obtained by Wedding are respectively 140 and 1·57, and are thus in substantial agreement with the others. It is, of course, obvious that the number of lamps taken was insufficient to get results which can be regarded as representing what may be expected from an average lamp bought in the market. Still they represent results obtained with great care under the most perfect conditions, probably, as to constancy of voltage. Another point with regard to these tests, about which more information might have been given, is with reference to the type of lamp to which the figures refer. As is well known, the Nernst lamp has been tried experimentally in a variety of models, most of which have been abandoned, and as the Reichsanstalt tests were made in May, 1902, though not published till lately, and as some of the figures refer to the horseshoe type of filament which is no longer made, being, in fact, a form of lamp which required to be lighted by a spirit lamp, and had no heater, it would seem that tests might with advantage be repeated on the most modern filaments, and results of a more extended series of observations published. A self-lighting filament, *i.e.*, a filament with an automatic heater, cannot be put on the same footing as regards watts per candle power with another filament requiring to be lighted by a spirit lamp; the heater is made to envelope the filament in its folds, and consequently obscures a certain portion of the light. Results therefore, which refer to lamps which are not lighted by an automatic heater are only of academic interest. The difference may be seen from the fact that the Reichsanstalt states that the watts per candle power of six horseshoe filaments taking ½ ampere at 220 volts was 1·57, these filaments having no heater; while the mean result obtained from six straight filaments, presumably supplied with heaters (though this is not definitely stated), was a consumption of 1·85 watts per candle power, these filaments also consuming ½ ampere at 220 volts. All these results refer to direct current lamps.

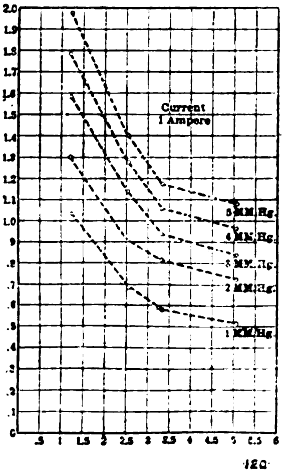
THE CONDUCTIVITY OF MERCURY VAPOUR.

The Cooper Hewitt lamp is not only interesting in itself, but also in the subsidiary development of points which present themselves in the investigation of the peculiarities of mercury arcs. Mr. Cooper Hewitt has lately published the results of some of his experiments on the conductivity of mercury vapour, and the extent to which the conductivity is influenced by the pressure of the vapour and temperature. Reactions due to electrical causes take place at three points in a column of mercury vapour when an arc is caused to pass through it, *viz.*, at the junction of the positive electrode with the mercury vapour, in the column of the mercury vapour itself, and at the junction of the vapour with the negative electrode. The real question to be decided was the extent to which the conductivity and luminosity of the vapour column depended on the pressure of the gas and indirectly on the temperature. For the purpose of experiment, the lamp was placed in a chamber constructed of heat-insulating material, the inside of which could be artificially heated by a resistance coil. The temperature within the tube was determined by two platinum-rhodium couples, sealed in the walls of the lamp at a measured distance apart, and extended to the centre of the column. By suitably connecting the outer terminals of these couples to a galvanometer, it was possible to equalise the internal temperature of the tube to the external temperature of the heating chamber by suitably adjusting the resistance of the heating coil. When the temperature was adjusted, the lamp was started, and the fall in volts along a column of given length, was determined by a Kelvin electrostatic voltmeter. Two of the diagrams are here reproduced, showing the extent to which the variations are interdependent. The first curve shows the extent to which the fall in volts depends on the current for the various mercury pressures; the second shows the effect which the diameter of the tube itself has on the variables.



Current in Ampères

The relation between voltage drop per c.m. to current in amps. for different pressures of mercury vapour.



Dia. of Tube in Centrimetres.

Relation of resistances per c.m.; voltage drop per c.m.; and watts absorbed per c.m. to the dia. of tubes in c.m. for different pressures of mercury vapour.

The author, who writes to the *Electrical World*, concludes that if a tube containing mercury vapour is to be employed as a lamp, maximum efficiency is obtained when the vapour density and current have a definite relation to one another. If current is passed at very low vapour density, practically no light is emitted; at higher densities, the efficiency from the point of view of light emissivity is increased. At very low densities, a transverse magnetic flux increases the resistance of the mercury vapour to a very marked extent; at higher densities, little alteration of resistance is noticeable. From the facts and figures here given, it is evident that much remains to be investigated before the perfect lamp is produced. When once they are started, the lamps seem to burn without trouble, and some observers have even remarked that fluctuations of voltage of the most marked kind do not affect the stability of the arc. But, seeing that the efficiency varies with other things which depend indirectly on the volts applied, it would seem that the battle is not yet won, and that much remains to be done besides mere shouting. The problem of starting the arc, too, is not without interest; and though it has engaged the attention of many experimentalists, it can hardly be considered to have been definitely solved.

PHOTOMETRIC TESTS OF THE NERNST LAMP.

Some interesting tests of the Nernst lamp and the mantle and naked gas lights have been carried on at Purdue University by Prof. C. P. Mathews, under the auspices of the National Electric Light Association Committee formed for the purpose. A series of tests was conducted upon the Nernst lamp of the one, three, and six glower types with various globes, shades and heater cases. The report showed that a change of 1% in the voltage made a difference of 6·38% in candle power. The most satisfactory photometric result was obtained under conditions of a constant current of 0·4 ampere per glower. The relative power consumption per unit of candle power is shown in Table I., in which the watts per mean hemispherical and per mean spherical candle power for each of the three types of lamp are given.

It will be seen that the three glower lamp is slightly more efficient than the single glower, there being, moreover, a considerable difference between the efficiency of the latter and the six glower lamp. This is accounted for by the higher temperature at which a number of glowers in close proximity must operate through mutual radiation, in spite of multiple glowers screening the light from one

TABLE I.—***Relative Power Consumption per Candle-power of One, Three and Six-glower Lamps, with Various Globes and Heater Cases.***

Watts per Mean Hemispherical Candle-power.

No. glowers	Opal heater case	Clear heater case	Clear globe	Opal globe	Sand-blasted globes
1	...	...	2·31	4·19	2·78
3	3·09	2·22	2·33	4·18	2·72
6	2·31	1·90	1·88	3·25	2·29

Watts per Mean Spherical Candle-power.

No. glowers	Opal heater case	Clear heater case	Clear globe	Opal globe	Sand-blasted globes
1	...	...	4·11	4·95	4·30
3	4·55	...	4·04	4·51	4·28
6	...	...	3·30	4·01	3·64

another in certain directions. For the same reason, in the lamp under consideration, if the glowers were increased, the horizontal intensity of the light will not increase in the same ratio as the downward intensity. To sum, up it may be said that the efficiency of the lamp in candle power per watt increases with the glowers, in spite of the screening effect mentioned. The six glower Nernst lamp, though taking about 20 %, more power than either the direct or alternate current series of arc lamps in common use, is yet a light source of the same order of brightness as regards maximum candle power.

TABLE II.

Angle.	Nernst six-glower.	Candle-power. Series arc, A.C.	Series arc, D.C.
Hor.	87	310	352
15° B.	248	375	404
30° B.	335	440	410
45° B.	373	445	375
60° B.	372	420	295
75° B.	380	355	290

Globes.	Clear	Opalescent inner, street shade.	Opalescent inner, clear outer.
E.M.F.	226·0	73·8	71·0
Current	2·4	7·5	6·6
Watts	542·0	469·0	459·0
Mean hemispherical c.-p.	289·0	394·0	360·0
Watts per mean hemispherical c.-p.	1·87	1·19	1·27

Table II. is a comparison of the three sources, the lamps on which the measurements were made being equipped for street service. The direct current lamp had an opalescent inner globe and clear outer globe, while the A.C. lamp was fitted with an opalescent inner globe and a metal shade.

* * *

LIGHTING & HEATING NOTES.

* * *

Fireproof Insulation for Cables.

Dr. Easton introduces a new method of insulating cables which is said to be due to a Mr. Heany, and the insultating substance to be able to withstand the temperature of fused copper without injury, or at least without breaking down. The advantages claimed for it seem fairly obvious. As the ordinary cable is insulated with a material that cannot be safely heated to any great extent without being decomposed or losing its mechanical strength, the new method, if it comes up to the promises made for it, would allow the use of smaller conductors for carrying a given current. Unfortunately the details given are of the scantiest kind. "The Heany insulation," says Dr. Easton in the *Electrical World*, "consists of a fibrous web so cemented together and treated by heat and pressure that it not only forms a compact and homogeneous mass in itself, but a chemical union with the copper wire, and this union is strengthened by heating, no matter to what degree. The insulation is not more costly than a double nap of cotton, and less in thickness, is practically indestructible, very strong and perfectly flexible, withstanding bending and twisting that will break off the wire before it parts." It is also moisture-proof, and the insulation resistance is higher than that of ordinary cotton-covered wire. All this sounds too good to be true. Curiously enough, though mention is made of Mr. Heany's laboratory, nothing is said of the place where it is being used, which seems to mean that its virtues have not yet been tested in the fiery furnace of everyday life. We can only hope that it will not be found wanting when it is put on the market. Still less do we hope that manufacturers will avail themselves of its fire-resisting properties by designing machines that can be run red-hot without injury to the insulation. However, the inventors seem to have lost sight of the fact that rise of temperature in a conductor is precluded as much by considerations of loss of energy as by thoughtful care for the well-being of the insulation.

American Critics.

It is reported that at a certain important meeting which took place in the provinces not long ago, the arc lamps hummed to such an extent as to be a serious nuisance. The report of these things has crossed the Atlantic, and we are therefore told we should be free from these troubles if we bought lamps and plant from America. We are further told by way of illuminating comment that the current was supplied by one of the much vaunted English municipal stations, These things may be so; but quite possibly current supplied by private enterprise would have caused the lamps to make the same inarticulate remarks, and even American lamps have been known to hum. But our critics are probably right in saying that these things ought to be avoided in the present state of our knowledge, and we also believe we can put them right without the help of any interested rivals.

Charging for Electrical Energy.

Mr. Ellis H. Crapper has just read an interesting paper on the subject of charging for electrical energy before the Leeds local section of the Institution of Electrical Engineers. He has collected a great deal of information, which should be studied by all practically interested in the subject. In an appendix, he gives figures, on the authority of the United States Consul-General at Berlin, showing the charges in many large Continental towns. The figures are here reproduced, as follows : –

Budapest	11·56d.	Dresden	7 38d.
Cologne	9·1d.	Frankfort	
Leipzig		Munich	
Nuremburg		Hamburg	
Genoa	8 8d.	Vienna	
Breslau	8·36d.	Christiania	6·9d.
Rotterdam		Copenhagen	

In Berlin the price is to be reduced from 6.6d. to 4.8d. from the beginning of the year. The above prices for a unit of energy seem very high compared with our own charges, and if they are correct, it is hard to understand how electricity competes with gas, unless the gas charge are correspondingly high. An interesting figure would be that showing the ratio of the charge for gas to that for electricity, but in so far as we know, these have never been comprehensively tabulated.

Rates for Lighting in United States.

A RECENT report of the National Electric Light Association contains some interesting figures relative to the rates charged for lighting and power in the United States. The old contract system is being rapidly replaced by meter systems, with certain modifications influenced by the nature of the service. The report points to a growing tendency to favour the consumer by lower prices. The old basis of 20 cents per unit with discounts, or about 1 cent per lamp hour, has very little vogue, and if used is frequently modified by discounts for prompt payments, large enough to effect a substantial reduction. Common prices are 15, 17 and 18 cents per unit, with generous discounts, although in regions of cheap coal lower prices obtain, as do they with water power plants generally. There are quite a number of installations charging as low as 10 cents per unit. Some few plants employ the maximum demand system, but the majority depend upon a fixed minimum monthly charge and service charges in one form or another. It is not uncommon to find an increased rate for residence lighting, in the west.

A Novel Heating Device.

AMONG the latest patents is one granted to Mr. R. A. Fliess, for electrically heating the handles of automobiles. The patentee says that numbness of the fingers on cold days is a serious nuisance on an automobile, when all one's activity is required to properly control the car. He finds that on the coldest day the consumption of 9 watts by a resistance concealed in the driving handle is sufficient to keep the hands pleasantly warm. Assuming this to be the case, it would seem that it is possible to keep the hands warm by the consumption of about one pennyworth of electrical energy on a long working day. The amount of energy required is small, and the comfort is said to be proportionately great.

World's Fair Supply.

THE following services of electricity will be available during the run of the St. Louis Exhibition :—Three-phase : 25 cycle, 104 volts ; two-phase : 60 cycle, 104 volts ; three-phase : 25 cycle, 6,600 volts ; two-phase : 60 cycle, 2,200 volts ; three-phase : 50 cycle, 2,200 volts. Direct current at 110, 220, 550 volts.

HOME BREVITIES.

The Maximum Demand System.—The Hampstead workhouse authorities find that since the introduction of the maximum demand system a saving of £51 was noticeable in six months, though no reduction in the lights had taken place.

Electricity in the House of Commons.—The ventilation of the House of Commons is now carried on by electric fans, which force in carefully purified air on the *plenum* system. Electric lighting has been unable to secure a footing since the unsuccessful attempt to introduce it 20 years ago.

Dublin Supply.—The Lighting Committee report that 383 consumers, an equivalent of 21,000 8-c.p. lamps, have been connected to the mains since the new Pigeon House works were opened. Several large institutions are negotiating for a supply.

Popular Electricity in Woolwich.—The Woolwich Borough Council, having in mind the fact that a large portion of its ratepayers have acquired houses through building societies, has adopted a gradual payment scheme for the installation of electricity for lighting, heating, and cooking. A good demand should arise, especially as an attractive showroom will be fitted up.

FOREIGN ITEMS.

New York Contractors' Association.—The United Electrical Contractors' Association, New York, held its annual meeting on January 19th last, when the welcoming address was delivered by Mr. J. C. Hatzell.

The N.E.L.A.—Decorative and sign lighting will form one of the chief features of the next volume of the transactions of the National Electric Light Association, and the report will be illustrated in colours.

Siberian Lighting.—Tomsk is the only town in Siberia possessing an electric light plant The industrial bureau holds the concession, but does not care to lay down additional plant, as the installation passes to the town in 19 years.

Train Lighting.—In *Dingler's Polytechnic Journal*, Jan. 9th, an illustrated serial on the above is concluded. A system exploited by Brown, Bouveri & Co. employs a shunt dynamo and small storage battery with special controlling apparatus.

Lighting in Ottawa.—Information covering the period 1898 and 1902, shows that there are three cities, twenty-three towns, and eight villages owning and operating electric light plants in this province. The capital provided for these amounts to £16,314, £114,670, £24,313 respectively.

Convention Exhibit.—Some thirty large firms exhibited at the North-Western Electrical Convention, held recently at Milwaukee. The Holophane Glass Co. exhibited in a dark room a 50 c.p. lamp, uncovered, and a 6 c.p. lamp covered with a globe, and the latter showed at least double downward illumination.

Municipal Electric Wiring.—We understand that numerous municipal authorities in London are seeking powers in Parliament to undertake the wiring of consumers' premises. The various wiring contractors' associations will, doubtless, have a word to say in the matter if decisive steps are taken.

Supply in Columbus.—Several companies supply electricity for lighting purposes in Columbus, Ohio ; but evidently they obtain their own price. Restrictions will soon be imposed, however, if the ordinance regulating the limit to 7 cents per K.W. is passed through the City Council. Some companies obtained 12½ cents.

The Iroquois Theatre Fire.—At the coroner's inquest on the bodies of those killed in the above disaster, the direct cause of the fire was attributed to the blowing of some loose drapery on the proscenium arch, into an open arc light. The subsequent spread of the conflagration being due to the lack of proper fire preventing appliances.

A Possible Amalgamation.—The Chicago Electrical Association is considering the possibility of becoming affiliated with the Society of Western Engineers. The organisation will then form the electrical section of the society in question. The latter possesses a fine library which would prove valuable to electrical men, while the benefits to the engineers themselves would be equally marked.

Electricity on a Chilian Battleship.—The Chilian battleship, "Libertad," described at length in ***Engineering*** recently, has 1,000 16-c p. lamps fitted, five 50 K.W. dynamos supplying the necessary energy. Gun metal section boxes are used in conjunction with water-tight distribution boxes. Five powerful searchlights are also installed, and these can be drawn under cover during action or stress of weather. The subject is being taken up on novel lines this year, and the opinion of prominent central station men will be embodied.

TELEGRAPHY & TELEPHONY

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegraphic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

* * *

Wireless Control of Torpedo Boats.

E Barthelmess, of Neuss, has invented a method of steering and otherwise controlling a torpedo or boat by means of electric waves. The boat itself is driven by compressed air. For the purposes of control, two synchronous clockwork mechanisms, one at the transmitter or controlling station, and one on the torpedo, are used. A coherer on the torpedo, when, affected by the electric waves, deflects the rudder, through a relay circuit, and at the end of the rudder's swing is decohered, when the rudder goes back to amidships. To control the direction of the rudder's movement, a commutator is provided on the second-hand of the clockwork which changes the connections, every two seconds say, from one to another of two electro-magnets controlling the displacement of the rudder. The second-hand indicates the instant at which an impulse or series of impulses has to be sent to effect a shorter or longer deflection of the rudder in the desired direction.

The steering gear is connected to the propelling motor shaft, W, by means of friction wheels, A_1, A_2, on a pivoted axis, C, which can be turned in one or the other direction by the pole-piece, A, placed between the magnets, S .S_2, thus causing the motor to drive one of the friction wheels, and, by means of a crank, I, actuate the connecting-rod H, which actuates the rudder. For an opponent to divert the course of the torpedo, it is necessary for the position of the commutator and the interval between the contacts to be known. Any such deviation, if effected, could be compensated for by suitably timed waves from the transmitter. Nothing is known of any practical trials of this system, and it is open to the usual objection applicable to all continuously running mechanisms where synchronism is required, and special periodic synchronising arrangements are lacking. It is pleasant to be able to record that England has produced the first actual wirelessly controlled vessel, though many inventors, in America or elsewhere, have suggested such possibilities. This is the dirigible torpedo boat of Mr. John Gardner, of Fleetwood. Any visitor to this Lancashire port could have noticed for some time past a small, partly-submerged craft, somewhat resembling a submarine on a small scale. This vessel, which has already made quite a number of runs, is controlled by methods very different from the one before described. No synchronous clockwork is required. The inventor has a transmitting station near by, and from this he can control

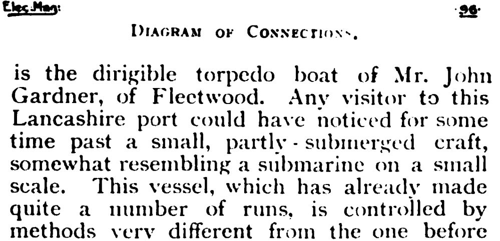
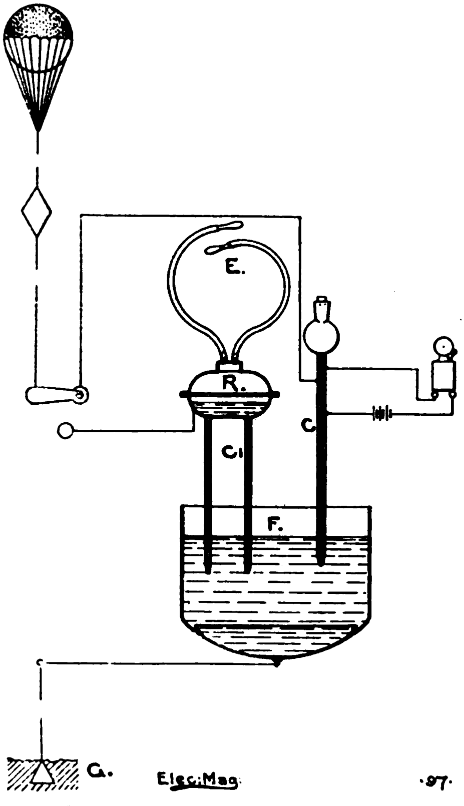


DIAGRAM OF CONNECTIONS.

all the operations of starting or stopping the vessel, steering in any direction, and exploding the charge carried, either with or without contact with the object to be destroyed. Although quite a number of runs have been made, there has been no accident of any kind beyond the propeller once fouling a submerged tree-branch some little distance from the control station.

A CAPILLARY RECEIVER.

A NOVEL receiver for wireless telegraphy is the subject of a patent recently issued to Mr. A. Plecher, of Bristow, Va. This consists of a capillary electrometer, the movement of the mercury in which gives the signals. Two electrometers of different sensitiveness are preferably employed, one to receive the call signal, and the other, of much more sensitive construction, to receive the message, the latter being switched in when the call has been received. In the diagrammatic sketch, C_1 C_1 are the electrometers, the capillary tubes of which are a little less than 1 mm. in diameter. The mercury does not extend to the lower end of the tube, which is open, and dips into a liquid consisting of potassium cyanide solution, to which is added 1 per cent. of silver cyanide and 10 per cent. of potassium hydrate. The solution is contained in a glass bowl, F, which has mercury at the bottom for making contact with the wire, *b*, leading to earth, G. In the electrometer, C, the one used for the call signal, the rise and fall of the mercury in the tube makes contact with wires sealed into the walls of the tube, as in mercury alarm-thermometers. In the message-receiving, one, two (or more) capillary tubes C_1 C_1 are joined at the top into a bowl, R, above which is an air chamber, R_1, hermetically sealed and provided with two ear-tubes, E. Some mercury is also placed in the bowl, R, for contact-making purposes. After the call has been received, and this electrometer switched in, the capillary columns, when affected by the Hertzian waves transmit their movements to the mercury in the bowl and thence to the air confined above it, so that audible sounds are heard through the ear-tubes, E.



CONNECTIONS OF CAPILLARY RECEIVER.

A STRIKING DEPARTURE IN MULTIPLEX TELEPHONY.

AN invention of considerable interest to telephone engineers is that recently announced by the issuance of a patent to Mr. Willard M. Miner, covering the art of practical multiplex telephony. The invention is a wide departure from recognised standard practice, though based on well-known laws of physics. The study of acoustics exposes a situation having unusual bearing on the transmitting of several conversations over one circuit, at one time. Mr. Miner, who was associated with the late Lieut. F. Jarvis Patten (who, as will be remembered, invented a system of multiplex telegraph apparatus), has also studied telephonic matters for 20 years, and has thus had more than a passing interest in acoustics as applied to music. Several years ago he and others acquired the patents and apparatus of Lieut. Patten, used in the furthering of his multiplex telegraph system, and undertook to apply the same to the development of multiplex telephony, but it was found, after exhaustive experiments, that the apparatus was commercially inoperative telephonically. Mr. Miner here began the application of his studies in acoustics to the transmission of speech in multiple, finding a wide difference between interruptions of the circuit and closing the circuit at frequent intervals. The transmission of speech, for instance, was found to

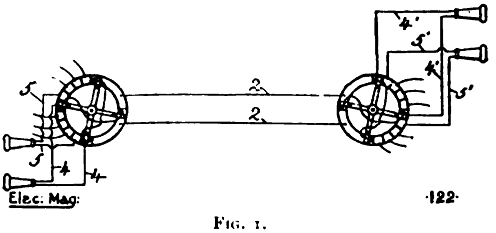


FIG. 1.

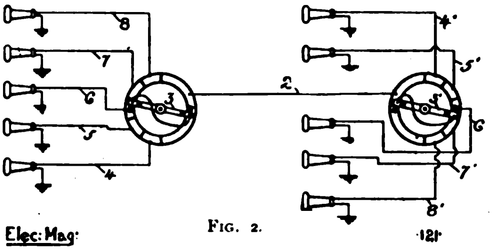


FIG. 2.

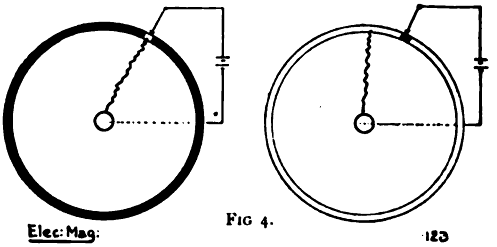


FIG 4.

be unaffected by 100 interruptions per second, and on this theory other investigators have been working for some time. A new area is, however, entered upon when the number of closures or contacts on which multiple telephony is based is considered. Speech can be conducted with 100 interruptions. With 100 contacts or closures per second, speech may be possible, but certainly it is not commercial. The basic principle, in multiplex telephony, is that of successively closing the circuit of the different branches or multiples of the line, it being requisite that all other branches should be disconnected except the one actually engaged. Mr. Miner concluded that, to secure commercial multiple telephony, contacts or closures corresponding as nearly as possible with the frequency of the vibration of the human voice in singing or speaking were needed. That is, the principle of the invention is to provide a contact or closure for each and all of the vibrations of the human voice in spoken words, and all musical tones. Synchronism, the fundamental feature of all multiple telegraph or telephone systems, is secured with the Patten-Miner system of multiplex telegraphy. The apparatus is run at a speed which brings the frequency of the closures of connection upon the several branches or sub-circuits up to a rate approximating in greater or less degree the rate of the vibrations of the overtones characterising speech. A rate of closure of 1,000 or 2,000 per second will not answer the purpose, but must be increased to 3,500 or 3,600 per second, the best results being obtained with a rate of about 4,300 per second. Figs. 1 and 2 illustrate in diagram a pair of rotating circuit closers or distributers in a typical form sometimes employed for multiplex or transmission over a single line circuit. The rotary arms at opposite ends of the line 2 are marked $3, 3^1$, respectively, and they are kept in synchronism by any means known in the art. Each is shown as rotating over five contacts, to which are connected respectively the five branch or sub-circuits, $4, 4^1, 5, 5^1, 6, 6^1, 7, 7^1, 8, 8^1$; the correspondingly numbered branches include the telephonic apparatus or sets of apparatus used in conjunction for conversation. The circuit shown is a ground circuit, but, as will be obvious, the apparatus might be arranged as is shown in Fig. 1, to provide a metallic circuit for each telephonic transmission. Fig. 3 shows one of the original Patten "mills" or distributors. Mr. Miner had this machine with him in the West in 1891 when making telegraphic tests between Chicago and Minneapolis, and another similar to it in his multiplex telephone experiments in New York City. In Fig. 4 the difference between 100 contacts or closures per second on an electric circuit and 100 interruptions per second is shown. If the two wheels shown are revolving at a speed of 100 revolutions per second, one will give 100 contacts per second, while the other will show 100 interruptions per second, with a decided difference, it is said, between the two sets of phenomena and the consequent result.

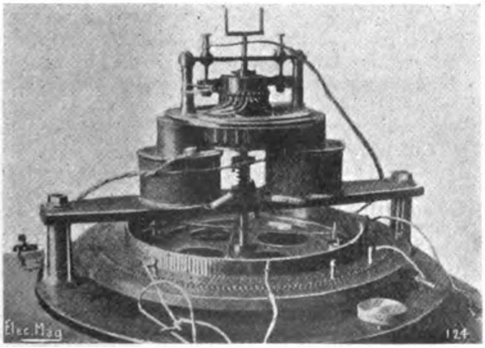
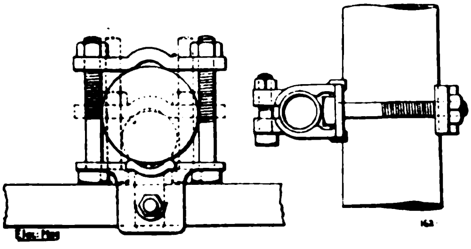


FIG. 3.

TELEGRAPH POLE BRACKET.

A USEFUL bracket clip for all sizes of taper poles, invented by Mr. J. Gray, is illustrated below. These clips are usually made in sizes to suit the varying diameter of taper tubes, but in this case the bolt holes in the saddle flanges and back are slotted, which admits of attachment on the tube in any ordinary position. Two jaws cast in one piece with the saddle grip the tubular arm and hold it horizontal, the tube being nipped by a nut and bolt passing through the outer extremities of the jaws. The tubular arm can easily be shifted laterally if desired, or removed altogether without unfastening the saddle and back from the poles. The diagram shows also another form of arm grip in which a bolt passes through both the ring holder and the tubular arm.



TELEGRAPH POLE BRACKET.

WIRELESS TELEGRAPH NOTES.

On a Novel System of Wireless Telegraphy.

Mr. E. Ruhmer, well known for his experiments in wireless telephony, has recently applied his method to optical telegraphy, and the Siemens-Schuckert Werke, Berlin, are just bringing out these novel wireless telegraphy apparatus.

In present systems of optical telegraphy, the rays issuing from a projector are, as a rule, intercepted at given intervals, so as to form luminous flashes succeeding one another more or less rapidly. In the Ruhmer telegraph system, on the contrary, the so-called "speaking arcs" are utilised, by superposing over the continuous current circuit of the lamp placed at the sending station in the focus of a projector, a continuous current frequently broken by means of a mechanical interruptor, the opening and closing being ensured by a Morse key in accordance with an ordinary Morse signal. At each closing of the telegraph scheme, the superposed and frequently interrupted continuous current will modify the candle-power of the electric arc, giving rise to luminous oscillations, which are projected towards the receiving station. If all the conditions be so arranged that the normal candle-power of the lamp remains constant, this process will ensure not only a more rapid handling of telegrams, but will permit, at the same time, of keeping the latter strictly secret, as the human eye, incapable of discerning any more than ten luminous alternations per second, will get the impression of a continuous beam, on account of the rapidity with which the luminous oscillations at the transmitting station will succeed each other.

The receiving station is arranged in a way analogous to those of optical telephony, comprising two telephones and one parabolic reflector, in the focus of which the selenium cell is placed. The luminous oscillations at the transmitting station are perceived in the telephone at the receiving station by means of the selenium cell as humming intermitting sounds, constituting *acoustical* and directly perceived *Morse signals*. The pitch of the sound will depend on the frequency of the interruptor. Whereas, in transmitting human language, incertainties are possible on account of the different acoustical intensities of the different vowels, the same sound will be heard here for more or less prolonged intervals. It has, therefore, been possible to ensure perfectly clear transmissions of signals in atmospheric conditions which would have rendered difficult the transmission of language. The beginning of a communication is indicated by a bell, operated by the selenium cell, without the agency of any wire connecting it with the transmitting station.

A Notable French Paper.

In a recent paper before the French Association for the Advancement of Science, Capt. Ferrié gives some interesting particulars of the effect of the Poldhu Marconi station on wireless stations in France. At Brest, 250 kilometres away, signals were hardly ever seriously interfered with, the length of the waves used there being about 200 metres. On the other hand, when communication had been established between Paris and Belfort, an interminable series of letter S's were received. Capt. Ferrié further describes experiments made to determine the carrying power obtained with direct currents and a spark-coil, as compared with alternating currents. With the same energy, it was found that the balance was in favour of the spark-coil and direct excitation of the aerial, which allowed of transmission over 400 kilometres with aerials 50 metres high, whilst with all other indirect excitation methods (direct or alternating current) 300 kilometres could not be exceeded. Of course with alternating currents there is no such low limit to the amount of energy which can be employed as in spark coils. For obtaining communication over the greatest distance (with a ship, say) without knowing the wave-length, it is best to employ direct excitation at the transmitter and an inductive or mixed receiver connection. On the other hand, with a well known station it is preferable to transmit with an inductive excitation and to receive with a shunt or mixed circuit connection. Whatever the connections, he considers it impossible to obtain independence of signals, that is, simultaneous service in two neighbouring stations. Capt. Ferrié, in the same paper, describes the emergency stations erected on Martinique and Guadeloupe after the Mount Pelée eruption had broken the cables. The apparatus was made in the military workshops, and messages were sent within three months of the first order for construction being received. Official and private messages were exchanged in a regular way, except when natural electrical phenomena occurred, which was every night and once or twice a month during the day. The power employed was 120 watts, with masts 55 metres high, but a cyclone having broken the top of the Martinique mast, the service was continued with the mast only 30 metres high, the distance being 180 kilometres. The installation, which has been working over fifteen months, will shortly be dismantled, as the cables are now repaired.

Ephemeral Applications.

A correspondent in a monthly contemporary waxes wroth over the irrepressible inventiveness which tries to prove that wireless telegraphy can do things which can be done, and much better done, by other means. He thinks that it is reasonable to expect to be able to do those things which, done by ordinary telegraphy, are not thought extraordinary. For instance, a wireless telegraph money order is regarded by the Daily Press as something supernatural. Telegraphy from moving trains he also considers a mistake, as, although feasible by other means, it has never been adopted, there being no demand for it. For fire alarm telegraph purposes he considers nothing can be more reliable than an ordinary wire circuit. It can be tested at any time, and with no complications at the protected building. What is even more important, though omitted by the writer, is that a wire circuit will enable the sending station to be identified, thus preventing false alarms. It is impossible for anyone at all familiar with wireless installations not to heartily agree with the author that such unnecessary applications are a waste of time, energy, and money.

On Wave Meters.

WITH reference to the new wave-meter of J. Dönitz, Dr. Drude writes to the *Elektrotechnische Zeitschrift* pointing out that he has used a simple apparatus (on the Lecher principle) for the last eighteen months, in which the position of resonance is indicated by a vacuum tube in dim light or by a spark-gap in daylight, an accuracy of ½ per cent. being obtainable with the latter. The apparatus is so simple that it can be made by anyone or, if desired, can be supplied by W. Schmidt, in Giessen. Dr. Drude considers that Dönitz, in introducing coils for the self-induction of the secondary circuit obtains by Stefan's formula too high a value of the self-induction (up to 30 per cent.) For the relative measurement of long waves he thinks the Dönitz instrument of use, but for absolute determinations considers his own method superior. Over the multiplicator spool method of Count Arco his has the advantage of lower capacity-reactance use of production of the absolute scale in λ, and greater accuracy. All the same, he considers the Arco instrument a very useful one.

International Communication.

EXPERIMENTS have also been recently conducted for the purpose of communicating directly between Germany and Sweden. The high-power station at Oberschöneweide, near Berlin, has been able to transmit signals to the station at the port of Kariskrona, a distance of about 280 miles, of which a good proportion is over land. From the Oberschöneweide station it was also attempted to communicate with Munich and Vienna; but owing to the heavy storms, experiments had to be abandoned both at Berlin and Munich, as it was found impossible to send up balloons or kites.

Wireless for Italian Mercantile Marine.

A CONTRACT has been concluded between the Italian Navigation General Co. and the Marconi Co., providing for the installation of wireless telegraphy on all the ships of the former company, for which 8,000 lira (£320) per ship is to be paid. In cases of necessity the Steamship Company has the right to a free use of the apparatus. For telegraphic service between two ships the Company will pay 0.3 lira per word for over thirty words; to the public the charge will be 0.6 lira per word (3d. and 6d. respectively).

Military Balloon Trials.

ACCORDING to the *Elektrotechniker*, Vienna, the Austrian Railway and Telegraph Regiment from Kornenburg experimented recently near Znaim in communicating with Kornenburg. Messages were satisfactorily received with a captive balloon at an altitude of 250 metres. The apparatus used was of the Braun-Slaby-Arco military portable wagon type.

An Interesting Record.

THE Gesellschaft für Drahtlose Telegraphie, who control the Slaby-Arco and Braun systems, state that, excluding Marconi stations, the number of installations erected on their system equals that of all other systems combined.

Russian Experiments.

THE short distance experiments, conducted by the School of Military Telegraphy, of St. Petersburg, gave such excellent results that it is proposed to carry on some tests over longer distances. New stations will be erected at Narva and Gatchina, and if the results obtained are satisfactory, a wireless telegraph service between St. Petersburg and Varsovia will be attempted, as well as with other places equally distant from the capital.

Practical Instruction in Wireless Telegraphy.

ALTHOUGH instruction in the principles of wireless telegraphy is already a feature at many schools, even in Germany, one of the first—if not the first—complete equipment for the purpose is that of the Elektrotechnical Institute of the Hochschule, in Vienna. On the roof of the building a large and commodious terrace is fitted with a full-size installation for the instruction of the students and for experimental purposes.

TELEPHONE CALLS.

Keen Competition in America.

SOME interesting particulars are given in the secretary's report of the Inter-State Telephone Convention held in Chicago in December concerning the progress of telephony in America. It is stated that the total capital represented by the Bell interests (the monopoly telephone administration, which is fully a quarter of a century old) amounts to over 530 million dollars, there being 1,277,983 exchange subscribers. This works out at 417 dollars capitalisation per subscriber. On the other hand, the various independent companies, whose lifetime is less than ten years, and who are the counterparts in America of municipal telephony in Great Britain, represent a capital of 200 million dollars, the total subscribers being two millions, and the capitalisation per subscriber being 100 dollars. As an instance of the advantage of competition in developing telephony, it was asserted that the state of Indiana, where between 5,000 and 6,000 telephones existed eight years ago, there are now no fewer than 100,000, the independent companies having by far the larger proportion. This increase has been carried on in face of keen opposition on the part of the Bell Companies, who spent millions of dollars in endeavouring to stem the tide of competition, but the independent companies continued to rise at the rate of 100 per month. Besides increasing the number of telephones in America, the competition has also brought about great reductions in charges. In many cases the rates quoted by the independent companies are 50% under the old charges of the Bell Companies. A comparison between the capitalisation per subscriber of the two administrations is interesting, as showing to what extent the capital of the original telephone concerns has been inflated, and how easy it is for new telephone administrations to build and operate telephone systems at greatly reduced charges. How the independent companies are able to make the business profitable is shown by the fact that 20 of the companies have, during a period of five years, shown net earnings of 8 to 16%. The figures given relating to the number of telephones does not include numerous smaller and rural companies, which cover no fewer than 500,000 telephones. According to these figures, there are not far short of four million telephones in the United States.

Cheap Telephones in Canada.

THE advocates of lower telephone tariffs in this country will be interested to know that an arrangement has been made between the Toronto Junction Council and the Stark Light and Power Co., by which the latter will provide, not only electric light and power service, but also a telephone system at the following rates:—25/- per annum and ½d. per call, with a maximum rate of £5 per annum for business telephones, and £3 for residences. Whenever the Company has 3,000 telephones in operation in the City of Toronto, two miles distant, the maximum rates will be increased to £8 and £4 respectively. The area covered by these rates extends to a radius of 15 miles from Toronto, and over 3,000 signed contracts have already been received. A similar offer by the same Company is at present being considered by the authorities of the City of Ottawa.

Telephones in Japan.

FOLLOWING the practice of the Western telephone administrations, the telephone authorities of Japan have decided to employ female operators for the day and night services in place of men. An improvement in the service is certain to follow, as, with all due respect to the male sex, men are not endowed by nature with those qualities which go to make satisfactory telephone operators. Would that telephone subscribers could substitute girls for office boys, as the latter are largely responsible for troubles which arise between subscribers and telephone authorities.

TELEGRAPH TAPPINGS.

A New Year's Eve World Wide Time Signal.

THE Government time service at Washington was inaugurated about fifty years ago, and with the aid of the telegraph has gradually increased in extent and importance. The Riefler clock, which is used for the transmission of the time, stands on a heavy masonry pier in a subterranean vault, enclosed in a hermetically sealed glass case, and kept at a uniform temperature. It is wound up, electrically, every ten seconds, and has an exceedingly regular rate. The error is only a very small fraction of a second. The electric impulses are sent by a small minute wheel, and operate a ten point relay with which are connected the lines of the Western Union Telegraph, the Postal Telegraph, and the American Telephone and Telegraph Companies, as well as several local systems. The transmission begins at 11.55, the last ten seconds before 12 o'clock are omitted, and a final beat at the exact hour is given. It was resolved, as a New Year's greeting, to make a more general distribution of the time signals than had ever been attempted, and this was achieved with great success by joining up every point of importance in the States, to Europe by Atlantic cable, to Cuba, Mexico City, Valparaiso, Santiago, Buenos Ayres, Ontario, Quebec, Alaska, Hawai, Midway, Guam, and Manilla. The transfer from the telegraph to the telephone lines was made by placing a telephone transmitter near a Morse sounder, the beats of which were distinctly audible in the telephone circuit. Wireless telegraphy was utilised simultaneously in flashing out the signal to numerous vessels at sea. Up to the last moment no delay in the regular traffic on the wires was allowed. At 11.55 p.m. the master clock was switched on and all work was stopped. The graphic account of this great event, which is narrated in the *Electrical Review* of New York, states that in five seconds after joining up, fifty thousand instruments connected by the slender lines that encircle the world were beating away in unison with the swing of the pendulum in Washington, the final beat ushering in the New Year.

Telegraphy in the United States.

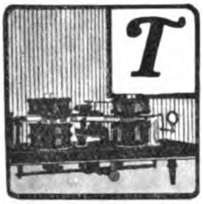
THE extraordinary volume of telegraphic business in the States has been productive of remarkable achievements with the Morse sounder. We are indebted to the *Electrical Review* of New York for the following figures:—Between New York and Chicago, on one side of a quadruplex nearly 1,000 miles, 1,001 telegrams were transmitted between 9 a.m. and 5.30 p.m. Of these 552 passed from New York to Chicago in eight hours and five minutes. From Chicago to San Francisco, 2,700 miles, one operator sent 526 ordinary telegrams between 8 a.m. and 5 p.m., being sixty per hour. A quadruplex between New York and Boston carries 2,000 telegrams from 8 a.m. to 5.30 p.m. daily. The extensive use of copper wires, whose resistance is over six times less than iron of the same gauge, the improvement in the insulation and construction of the apparatus, poles and fixtures, and the large increase in the use, by the receiving operators, of typewriting machines, since their first introduction twenty years ago, have all contributed to an improvement in the service and a higher traffic capacity of the wires. The Wheatstone automatic system, introduced in 1880, has decreased, notwithstanding the enormous increase of traffic handled by an increase of the Morse system. An ingenious modification of the Wheatstone was recently made by C. L. Buckingham, who replaced the Wheatstone tape marked with the received signals in ink, by a printer automatically recording the messages in Roman characters in page form. The Wheatstone works duplexed, and a circuit between New York and Chicago is capable of carrying 5,560 ordinary telegrams between 9 a.m. and 5.30 p.m. The Edison phonoplex and the Crehore duplex-diplex are also in use to a very limited extent. These systems both superpose a phantom circuit upon a single Morse wire without interference with the Morse operation, making two simultaneous communications possible either in the same or in opposite directions. A keyboard transmitter, which is designed to take the place of the Morse key, has been devolved by C. E. Yetman, of New York, so that sending operators may transmit letters by touching their respective keys as in typewriting, instead of using the fingers of one hand to manipulate a single key.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable; that coal may absolutely be removed from the ranks of necessary commodities; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

The Electric Iron and Steel Processes.

By J. B. C. KERSHAW, F.I.C.



THE various methods and processes for applying the electric furnace to iron and steel production continue to attract considerable attention, and recent issues of the French, German, and English technical journals devoting space to electro-metallurgical developments, contain many articles and notes on this new application of electrical energy. In a subsequent issue the writer will give an illustrated and descriptive account of all the processes and furnaces that have received industrial trial, and therefore in these notes he will merely deal with the more recent technical literature of the subject.

France, it may be remarked here, is the country which is leading the way in this new development of electro-metallurgy. This is due partly to the natural bent and genius of French engineers for metallurgy, and partly to the slump in the calcium carbide industry in the years 1899-1900. This collapse left a very large number of water-power centres in the south-eastern districts of France, which had been specially developed for carbide manufacture, unprovided with any outlet for their electrical energy, and the power at many of these centres has now been applied to the new industry.

M. Heroult, of the La Praz electro-metallurgical Works, and inventor of the Heroult aluminium process, was one of the first to experiment in this direction, and he has recently published an interesting and detailed account of the experiments, which led up to his ultimate success in the manufacture of tool steel of high quality in the electric furnace. The early trials date from 1899, when a new form of furnace for the production of ferro-chrome alloys was being designed. The special feature of this furnace was the use of two carbon electrodes, with the molten metal as an intermediate, the arc thus passing from one electrode *to* the metal, and *from* the metal to the other electrode. The electrodes did not touch or dip into the metal, and the furnace itself thus acted simply as a container for the molten mass. The only difficulty met with in working this type of furnace, arose from the variation in the resistance, and therefore in the length of the arcs, and Heroult overcame this by the use of a small subsidiary electrode, between the other two. The Heroult furnace, designed specially for steel production on these lines, is covered in, and is mounted on rockers to facilitate discharge by tilting.

Originally the cast iron used for charging this furnace was also produced by an electro-thermal process, 250 tons having been smelted from the ore at La Praz, but this method of preparation of the raw material has been discarded, and all the surplus power at La Praz is now being devoted to the more profitable refining operation, by which scrap-iron and pig-iron are converted into high quality tool steel.

The impurities of the raw-iron, silicon-phosphorus, etc., are removed by the use of suitable slags, and the refining process, as carried out in the Heroult furnace, is therefore virtually a "*washing-out*" of the impurities from the molten iron, by aid of electric heat and certain chemical fluxing compounds.

The Heroult process is reported to be successful, and 2,500 tons of high-class tool steel have already been produced by it at La Praz, in France, and at a water-power centre in Sweden. M. Heroult has informed the writer that the present output by his process in France is between six and seven tons per day, and that about the same amount is being produced in Sweden. A large iron-works is also about to adopt the Heroult process, the waste gases from the blast furnaces being utilised in this case to generate the required electrical energy by means of gas engines coupled to dynamos. When this new plant is in operation, the output of steel by the Heroult process is expected to reach 150 tons per 24 hours.

The Keller furnace and process is another French process for electric steel production which has attracted considerable attention, chiefly owing to the fact that M. Keller read a paper upon it before the Iron and Steel Institute, in London, in May, 1903.

This process, from the published accounts, seems to resemble in all points the Heroult process of steel production, and it is in operation at Kerrousse, near Morbihan, and at Livet, on the Romanche, in France. No very recent information is available relating to the progress of these two works, and it is not possible to give any figures for the production of steel, by the Keller process and furnace in France. The furnace now in operation at Kerrousse is understood to be capable of producing between fifteen and twenty tons of steel at one charge, and it absorbs 375 h.p. At Livet, a similar furnace is employed, and in this furnace Mr. J. E. Stead, of Sheffield, saw 850 kgs. of scrap-iron melted in two hours, when he visited the works in 1902, this weight requiring 600 K.W. hrs. for its conversion into steel. The weight of slag obtained is reported by the same authority to be 6 cwts. per ton of steel,—sand and lime being employed as fluxing materials.

The Kjellin electro-steel process which is in operation at the Gysinge Foundry, in Sweden, differs from all others, in the method used for generating heat in the mass of metal which is to be refined. In place of arc heating, resistance heating is utilised,—and in place of direct currents, "*induced*" currents are employed, the metal being used to complete the secondary circuit of the system.

According to Mr. J. Ritchie, of Glasgow, who visited the works at Gysinge, in November, 1902, the capacity of the furnace used at that date was 35 cwts., and a current of 70 to 90 ampères at 3,000 volts was required for six hrs. to produce one ton of steel. This is equivalent to 1,440 K.W. hrs. per ton of steel, and the cost of refining is given by this authority as 11/- per ton. Mr. J. F. Melling, the agent in this country for Gysinge steel, has also furnished the writer with some details of the development of the Kjellin process and furnace. The process was patented in 1899 and the first furnace was erected and tried at Gysinge, in March, 1900. The capacity of this furnace was only one cwt., and after satisfactory results had been obtained with it, a larger furnace, capable of taking one ton charges of metal, was erected in the winter of 1901-1902. The manufacture of electric steel has been continued at Gysinge regularly since these dates. The advantages offered by Gysinge electro-steel over ordinary tool steel are stated to be as follows :—1. Greater ductility.—2. Greater absolute density.—3. Greater softness of the unhardened steel.—4. Greater uniformity in quality.—5. Greater facility in welding. The price varies from £2/10/- to £2/18/- per cwt. c.i.f. Stockholm. According to a U.S.A. consular report, 1,500 tons of steel are now being produced annually in Sweden by the Kjellin process.

References.

HEROULT PROCESS.—	Electrochem. Ind. Sept. 1903.
KELLER PROCESS.	Trans: Iron & Steel Inst. 1903. Elec. Rev., N.Y. June 6 & 13, and Dec. 12, 1903. January 9, 1904.
KJELLIN PROCESS.	Trans: Iron & Steel Inst. 1903. Elect. Rev., N.Y. June 6 & 13, 1903. Trade Circular. Gysinge Steel. 1903.
RUTHENBERG PROCESS.	Electrochem. Ind. Oct. 1903. Trans: Am. Electrochem. Soc. 1903.

BLONDLOT'S N RAYS.

R. BLONDLOT has continued his researches on the newly-discovered N rays, and has embodied the results in several further communications to the Paris Academy of Sciences. He finds that many substances, when exposed to the action of the N rays, acquire the property of acting as secondary sources for the emission of these rays for a considerable period after the withdrawal of the original source of illumination. Among these are quartz, Iceland spar, fluor spar, glass, gold, lead, platinum, silver, and zinc. Paper, wood, and aluminum do not possess this property. He found that bricks and pebbles, after exposure to sunlight, continued to emit N rays for four hours without sensible diminution. It is essential that the surfaces of the substances experimented upon should be maintained in a condition of dryness, as the slightest coating of moisture is found to be sufficient to absorb the rays completely. While water absorbs the rays, a dilute solution of salt allows them to pass freely. It was probably for this reason that the eye of an ox was found to be transparent to the rays. The eye was also found to act as a secondary source after the original source of light was cut off. Sodic hyposulphite, either solid or in solution, was found to act as a powerful accumulator of these rays. M. Blondlot finds that N rays are emitted by bodies in a state of strain, either molar, as in the case of the strain produced by bending, or molecular, as in the case of tempered steel and glass. The effect of annealing is to destroy the property.

A. Charpentier, in a communication to the Academy of Sciences, in December, describes his success in reproducing many of Blondlot's results. He also finds that N rays are emitted by the human muscles and nerves when in a state of activity. Working with a screen of barium-platino-cyanide, rendered faintly luminous by means of radium enclosed in black paper, he found that the luminosity of the screen was sensibly increased when N rays were allowed to impinge upon it. This increased luminosity was very noticeable when the screen was brought near to a nerve or muscle, the effect observed being more intense, the greater the activity of the muscle or nerve. This observer finds that the rays may be reflected or refracted. He points out that the observed effects cannot be due to heating, as they are transmitted through a series of aluminium plates separated by air spaces. He considers that they cannot be attributed to stored sunlight, as they were still observable after the exciting substances had been kept for nine hours in darkness. M. Charpentier considers this demonstration of a direct external action of an excited nerve to be of the greatest physiological interest and significance.' In a further communication, published in January, the same observer describes some remarkable differences noted in rays given out by the human body according to their muscular or nervous origin. The rays emitted from the nerves are absorbed more completely by aluminium than by lead; but the interposition of aluminium has scarcely an appreciable effect on the rays emitted by the heart, the diaphragm, and the muscles generally. The slightest amount of nerve compression largely increases the emission, an effect which is not observed in the case of the muscular emission. Noteworthy differences are also observed in the phosphorescent action of nervous and muscular emissions respectively.

T. M. de Lépinay, in a communication to the Academy of Sciences, on January 11th, describes successful observations of the effect of sound waves in causing the emission of N rays by the sounding body. Such a body is subject to a large number of alternate deformations in each second. The increased luminiscence of a calcium sulphide screen under the influence of sound vibrations was most marked, and the experiments showed that the effect was due to the air waves.

E. Meyers, in a communication which appears in the same issue of the *Comptes Rendus*, describes some interesting experiments on the emission of N rays from plants. He finds that the green portions and the roots are much more effective than the flower. The phenomenon appears to be closely connected with the activity and the condition of development of the protoplasm. For example, a tube containing cress seedlings was found to produce a very sensible increase in the luminosity, while a similar tube of non-germinated seeds showed no effect. The suspension of the vital activity of the seedlings by means of chloroform caused a cessation of the N rays emission.

M. Charpentier gives details of further experiments in the *Archives d'Electricité Médicale*, of January 25th. Living screens, such as those prepared by Macé from certain bacilli, show increased luminosity under the influence of the rays emitted from muscles, nerves, and nerve centres. He finds that the effect of a muscular action, such as the bending of an arm, may be traced to its motor centre in the brain or spinal marrow. Efforts of mutual activity, such as concentration of the will, are found to produce an immediate increase in the N rays emission, as observed by increased luminosity of the screen.

The *Comptes Rendus* for January 18th contains an important paper by Blondlot on the refraction and dispersion of N rays, from observations on which he deduces these wave lengths. They are found to occupy the extreme ultra-violet portion of the spectrum, the smallest wave-lengths observed having some fine octaves beyond the extreme ultra-violet hitherto explored. The spectrum of the N rays was formed by means of an aluminium prism, as this substance refracts the rays, but does not act as a source of secondary emission.

In a communication to the *Comptes Rendus* of Jan. 25th, M. Charpentier describes further experiments in which N rays from the human body and other sources, were allowed to impinge upon a copper plate connected to a copper wire several metres in length, the further end of which was wrapped about a sensitive screen. All the effects previously observed were reproduced, but in a lesser degree, showing that the waves of which these rays consist, are capable of transmission along a wire without losing their characteristic properties.

G. W. DE TUNZELMANN.

ELECTRO-PHYSICAL NOTES.

Degradation of Radium into Helium.

THE production of helium from radium, first observed by Ramsay and Soddy, has been observed under different conditions, described in a communication to the *Comptes Rendus*, of Jan. 25th, by Messrs. Dewar and Curie. Some radium bromide was kept for three months in a glass tube communicating with a small vacuum tube and a mercury manometer. During the whole time there was a slow evolution of gas, and spectroscopic observations showed the presence of hydrogen and mercury vapour only. The contents were then sealed up in a quartz tube and fused. Spectroscopic observations of the gases evolved then showed the presence of nitrogen only. The substance remaining in the tube was then sealed up again, and, twenty days later, was examined by M. Deslandres, who observed the spectrum of sparks produced within the tube by means of an induction coil. The complete spectrum of helium was then observed without any trace of nitrogen. The permanent luminosity of the tube gave a continuous spectrum without any lines.

Use of Rapidly Rotating Kathodes.

Rapidly rotating kathodes have been very successfully employed by Cowper Coles for the electro deposition of copper and some other metals. In a communication to the *Zeitschrift für Anorganischen Chemie*, Messrs. Gooch and Medway describe the successful application of this method in electrolytic analysis for the complete elimination of various metals from their solutious. J. G. Zimmermann, in a communication to the American Electro-Chemical Society, describes a series of experiments in which he found that the electro depositions of nickel, silver, iron, and lead was greatly facilitated by the use of a rapidly rotating kathode.

Metallic Conduction on the Electron Theory.

In an important contribution to the *Philosophical Magazine* for February, Prof. A. Schuster discusses the conduction of electricity by metals in light of the electron theory. He deduces, from optical considerations, that the ratio of the number of free electrons in a metallic mass to the number of atoms which it contains, lies between the limits 1 and 3, so that every metal contains at least as many free electrons as atoms. The author then explains metallic conduction by the assumption that these free electrons freely follow the electric force, even in the case of such extremely rapid oscillations as those which give rise to light waves.

Electrodeless Discharge.

In a paper recently communicated to the American Physical Society, B. Davis describes some important experimental results, which may be summarised as follows: The minimum voltage per centimetre required to produce discharge depends on the nature of the gas. This minimum and the pressure at which it occurs depend on the oscillation frequency. The voltage per centimetre is independent of the frequency for pressures above the critical point. The volts through which an ion must fall freely, in order to produce new ions by collision, is shown to be 2·4 for air, and 1·66 for helium. The mean free path of an ion is shown to be, approximately, four times as long as that of a molecule.

The Selenium Cell.

In a recent paper in the *Zeitschrift für Anorganischen Chemie*, R. Marc describes some interesting experiments made to ascertain the suitability of selenium cells for spectro-photometry. He finds that the sensitiveness of the cell to light of various colours varies with the temperature and the current. The resistance also varies with the current. Sale has shown that selenium is most sensitive to the infra-red rays, decreases continuously as the violet end of the spectrum is approached, and disappears entirely for the actinic rays. The present author shows that the sensitiveness to red light is considerably diminished by previous intense illumination with white light, or when permanently illuminated with blue light. The author arrives at the conclusion that the action of light on the cell, instead of being confined to the illuminated portion of the surface, as is usually supposed, is transmitted to a certain depth. He is opposed to Bidwell's opinion, that the photoelectric properties of selenium are due to the presence of metallic impurities. A. H. Pfund, in a communication to the January number of the *Philosophical Magazine*, finds that sensitiveness increases with the purity of the selenium. He came to the conclusion, contrary to Bidwell's view, that the effect of light in decreasing the resistance was not dependent on whether a current were flowing through the cell or not. He disagrees with Bidwell's view that the selective sensibility of the cell is due to the presence of selenide.

Suppression of Hysteresis.

Recent experiments made by Marconi and Tissot with the magnetic detector have directed attention to the action of a rapidly varying magnetic field on magnetization. The former attributes the observed effects to suppression of the time-lag, or magnetic viscosity; while Tissot maintains that there is a modification of the hysteresis. C. Maurien, in a recent communication to the French Academy, shows that, under certain conditions, the magnetic hysteresis may be completely compressed. He found this to be the case when an iron or steel core was exposed to the action of a magnetic cycle, and of a continually oscillating field in the same direction, provided the core were thin enough to allow the oscillating field to penetrate it completely with practically undiminished intensity. P. Dahern, in a later communication to the Academy, discusses the subject theoretically, and arrives at the conclusion that this suppression of hysteresis in rapidly oscillating fields is brought about as an effect of the magnetic viscosity.

* * *

The Conductivity of Selenium.

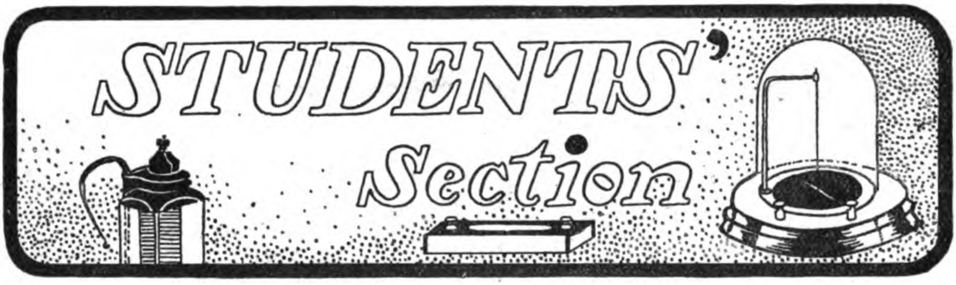
Mr. E. A. Hopius, in an investigation recently presented to the Russian Physico-Chemical Society, has made a series of experiments with an apparatus constructed by Mr. H. Kohl and another apparatus designed by himself, on selenium, the former being illuminated by a standard amyl-acetate burner at distances ranging from 10 to 200 c.m., and the other by a Nernst lamp placed at the same distances. The measured current intensity agreed fairly well with the hypothesis of a direct proportionality between the increase in the conductivity of selenium and the cube root of the intensity of illumination.

Action of Radium Rays on Explosive Potentials.

The property of radio-active bodies of lowering the discharge potential, or in other words augmenting the explosive distance which they share with ultraviolet rays, has been observed by many experimenters, though no systematic investigation has yet been forthcoming. Moreover, with all the investigations so far made, low potentials were exclusively used, 800 volts being the upper limit. It is inferred from a paper recently read before the Russian Physico-Chemical Society by A. P. Grusintzew that :

(1) the lowering influence of radium will diminish with the distance, and

(2) the maximum lowering of the potential will be displaced towards shorter explosive distances, as the distance of the radium is increased.



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of *The Electrical Magazine* feels that something more is wanted, and the Associate Editors, will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

* * *

Principles of Polyphase Currents.

By ELLIS H. CRAPPER, M.I.E.E.

Many branches of modern engineering practice involve the generation, transmission, and utilization of energy, and since much of the progress which has been made in the arts and manufactures in recent times is due to the part played by electricity, considerable interest is now paid to the subject of the transmission of power electrically. Probably the most important problem encountered by the engineer at the present day is that of transmitting power efficiently over great distances, and many improvements in electrical machinery and methods of transmission have been introduced now that the successful application of electrical energy for power purposes has been conclusively proved and demonstrated on a commercial scale to a degree which indicates that the earlier application of electricity for lighting has been completely overshadowed. The transmission of energy by means of alternating and polyphase currents has, in fact, developed with extraordinary rapidity both in America and on the Continent, and, inasmuch as polyphase currents are equally well adapted for power and lighting purposes, many engineers are of opinion that polyphase currents supply a full and adequate solution of the problem of transmitting power efficiently for varied and general purposes.

As is well known, polyphase currents are a species of alternating current, and an alternating current is one which varies in an undulating and periodic manner relatively to the time, both in magnitude and direction. The term polyphase currents, as the name implies, is applied to the system of utilising two or more separate and distinct alternating currents of the same amplitude and frequency, but possessing mutually a definite phase displacement or relationship as regards time with one another. A polyphase system is, therefore, one which employs three or more distinct wires or conductors, and a combination of two or more independent alternating currents, which attain their maximum and minimum values at different instants of time, and the interval of time which elapses between which they individually attain the maximum value, say, is the same and a definite fraction of their periodic time. The characteristic principle of polyphase currents is, therefore, the phase-displacement as regards time which exists between the currents.

Let Fig. 1, for instance, represent a multiphase system in which q wires arrive at a receiving station; when the individual wires

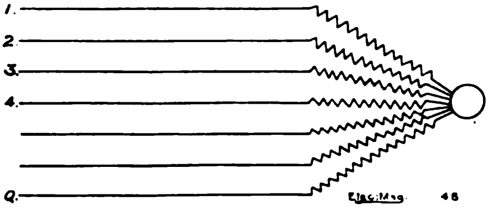


Fig. 1.

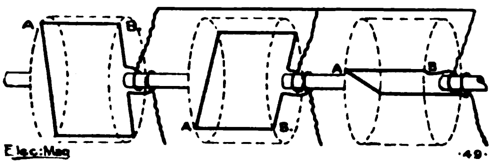


Fig. 2.

are traversed by symmetrical sinusoidal alternating currents, the maximum value of each of which is C, the magnitude of the individual currents in the wires 1, 2, 3 . . . . q at any instant whatever will be given by the values

$$C \sin pt;\ C \sin \left(pt - \frac{2\pi}{q}\right);\ C \sin \left(pt - \frac{4\pi}{q}\right);$$
$$C \sin \left(pt - \frac{q-1}{q} 2\pi\right)$$

since, when there are q phases, the phase-displacement must be $\frac{2\pi}{q}$. If $q=2$, we have the ordinary *single-phase* alternating-current circuit ; if $q=3$, a *three-phase* circuit results; and when $q=4$, a *two-phase* circuit is formed. Generally, the number of separate currents is limited to two or three, forming, in practice, *two-phase* or *bi-phase* and *three-phase* or *tri-phase* systems. Polyphase generators are, therefore, *two-phase* or *three-phase* machines; a two-phase alternator is one which generates two alternating electro motive forces of the same frequency, amplitude, and wave character, but differing in phase by a quarter of a cycle or 90°, and when the receiving mechanism is connected to such a machine by four conductors, two-phase currents result, which are precisely of the same nature, and go through exactly the same changes as regards intensity and direction, but which have a phase relationship as regards time, equal to a quarter of a period, *i.e.*, are in quadrature with each other if the impedances of the two distinct circuits are the same. In other words, one is a maximum when the other is a minimum, *i.e.*, has its zero value; and, furthermore, the two currents will lag behind their corresponding E.M.F.'s by the same amount. Similarly, when an alternator generates three alternating electro-motive forces of the same frequency, amplitude, and wave character, but differing in phase as regards time by a third of a period or 120°, the machine is known as a three-phase or tri-phase generator.

It is not the function of this article to deal with the design of polyphase generators, but it may be remarked here that the principles underlying the generation and action of polyphase currents differ but little from those of the single-phase alternator. Reference to Fig. 2 will make it clear that if three exactly similar coils are supported rigidly to a common shaft so as to be capable of rotating in three identical magnetic fields formed by three sets of bipolar field magnets disposed exactly alike (these field magnets are not shown in Fig. 2), then three equal electromotive-forces will be set up having a phase relationship of a third of a period or $\frac{2\pi}{3}$. It is also equally clear that the arrangement shown in Fig. 2 is purely diagrammatic, and that the same result may be obtained if three sets of windings be placed on a single armature core, and be so disposed with respect to the field magnet poles that the required phase relationship is obtained. Such an arrangement is shown in Fig. 3, and by the proper disposal of distinct sets of armature windings on a single armature core with respect to the pole pieces any desired phase-relationship may be obtained. As with single-phase alternators the ends of the separate windings are connected to slip-rings, the number of which depends upon the scheme of winding, which will be explained presently.

An important and characteristic property of three-phase working is that only three line wires are required for the transmission of electrical energy by means of three-phase currents; consequently economy in copper is effected in the construction of the line wires. When the number of phases exceeds two, ***the algebraic sum of the instantaneous values of the symmetrical sinusoidal alternating currents is zero.*** This is obvious in the case of three-phase currents, where the phase-angle is $\frac{2\pi}{3}$ or 120°, for by taking the sum of the ordinates of the three curves given in the wave diagram (Fig. 4) at any instant whatever their sum is zero. By trigonometry it may easily be proved that the algebraic sum of the instantaneous values of three-phrase currents, expressed as follows: $C \sin pt + C \sin (pt - 120°) + C \sin (pt - 240°)$, is zero.

To further explain this important principle let us consider the examples shown in Fig. 5, and imagine that we have represented in Fig. 5*a* three separate and independent, perfectly symmetrical sinusoidal single-phase alternating current circuits, each fed by an identical single-phase alternating current generator, and that in each circuit there are the same number of lamps, *i.e.*, that the current is the same in each. In this case six separate

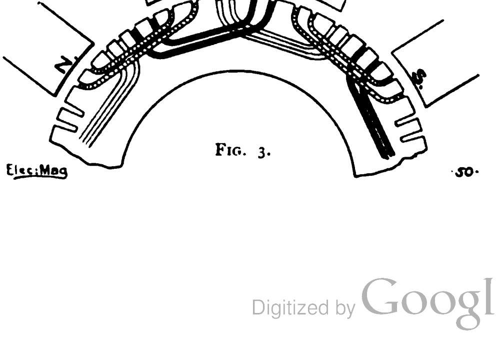


Fig. 3.

wires are required, but a little consideration will show that it is possible to attain the same result by using the three generators and only four line wires, as shown in Fig. 5*b*, in which case the fourth conductor forms a common return, and the working of the system will not be affected provided the generators generate the same pressure and their corresponding terminals be connected to the common return wire, which will be at the same potential as the three return wires in Fig. 5*a*. If the system be perfectly symmetrical, *i.e.*, if the three currents are equal and in phase with one another, then the current in the common return wire will be the sum of the separate currents, and its cross sectional area must be increased proportionately. As a special case, let us consider what happens when the corresponding coils of the generators are displaced one-third of a period relatively to one another, so that a typical three-phase system with a phase relationship of 120° is secured, then, since the sum of the three currents at any instant is zero, no current will traverse the common return wire, and it may be dispensed with absolutely. The arrangement is shown in Fig. 5c, but the ideal case occurs when the three generators are replaced with a three-phase alternator, and the three corresponding ends of the three distinct armature windings are connected together, as well as a common junction being formed at the receiving station.

The fact that only three lines are necessary for a three-phase system has given rise in practice to two distinct methods of interconnecting the six ends of the three armature windings of a three-phase generator. These methods depend upon whether each of these windings is connected *in series with*, or *parallel to*, the other two, and they are known respectively as (1) the *triangle*, or *mesh connection* (Fig. 6*a*), and (2) the *star connection* (Fig. 6*b*). It may be remarked here that similar methods of connecting the stator windings of three-phase induction motors are adopted in practice. In Fig. 6*a*I, a gramme ring is wound continuously with wire, and the complete winding is divided into three equal parts at the equidistant points *a*, *b*, and *c*, so as to represent the armature winding of a two-pole three-phase alternator, and it will be observed that the two ends of each separate section terminate at two different collecting rings. Since there are only three collecting or slip rings, it is clear that each ring has one end of two different coils connected to it, and in this way a *closed mesh* or *triangle coupling* is formed, and the symbol, Δ, is frequently used to denote such a closed polyphase armature connection.

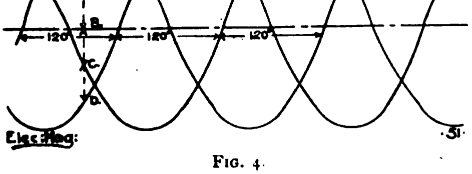


FIG. 4.

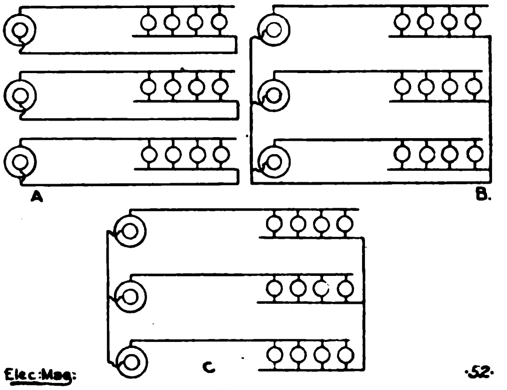


FIG. 5.

If the ends of the three coils be not interconnected, but be kept distinct and separate, the E.M.F. set up on open circuit in the respective coils would be at any instant whatever

$$e_1 = E \sin pt$$
$$e_2 = E \sin (pt - 120°)$$
$$e_3 = E \sin (pt - 240°).$$

But if they be connected in series with one another, as shown, no current will pass through the complete armature (provided no connection is made with an external circuit), according to the theorem previously explained; definite differences of potential, however, exist between the points of junction *a* and *b*, *b* and *c*, and *c* and *a*, respectively, and they may be considered as sources of potential difference which give rise to three-phase currents if the three points of junction, *a*, *b*, and *c* are connected by means of three line wires to the terminals of a three-phase motor. The diagrammatic method of representing the mesh, triangle or delta connection is given in Fig. 6*a* II. In the case of a polyphase system of *q* wires, the diagrammatic representation of the mesh connection of the armature winding would be that of a polygon of *q* sides.

The second method of connecting the armature winding of a polyphase generator is shown in Fig. 6*b*, from which it will be seen that the three symmetrical ends of the three groups of windings are connected together so as to form a common junction or neutral point, O, and the three other ends are connected to three slip rings, *a*, *b*, *c*, which make connection to the three wires of the distributing system. It is thus clear from Fig. 6*b* II, that the three armature coils are connected in series with their corresponding line wires, so as to radiate or branch out in a star wise fashion from the neutral point to the line wires. For this reason the arrangement is termed the ***star connection***, and it is frequently represented by the symbol Y. In transmission circuits it is common practice to earth the neutral or common junctions, since by this means the potential of each line wire is maintained within the limit corresponding to the voltage of the generator. A simple modification of the star method of grouping is indicated by the dotted line shown in Fig. 6*b* II, which is a fourth or neutral line wire connected between the common or neutral junctions, from which it is obvious that lamps or other appliances may be connected between this zero line and the distributing lines I, II, and III, as may be desired. This arrangement cannot be introduced into the mesh connection. The disposition of the armature windings of a two-pole three-phase alternator is shown in Fig. 6*b* I; it must be noted, however, that the three-phase alternators are usually multipolar machines.

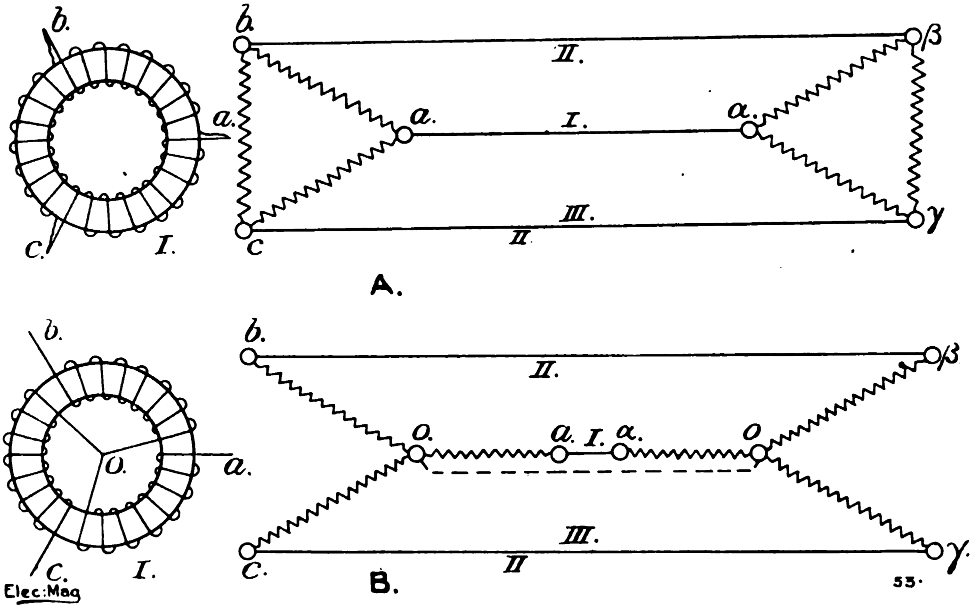


FIG. 6.

The two systems of inter-connecting the windings of three-phase armature windings are not equivalent as regards the available pressure and currents, and each possesses characteristics of working. In the case of the mesh connection, it is clear that the difference of potential between the junction points *a* and *b*, *b* and *c*, and *c* and *a* is the same as the E.M.F. generated in the coils II., III. and I.; but in the case of the star connection it is not so. Let the vectors OA, OB and OC (Fig. 7, I.) represent the effective values of the E.M.F.s generated in three coils at any instant when the machine is running on open circuit; then if V_o be the common potential at the neutral point O, and V_a, V_b and V_c be the potentials at the extremities A, B and C respectively, we have

$V_a - V_o$ denoted by the line OA.

$V_b - V_o$ denoted by the line OB, 120° behind OA.

$V_c - V_o$ denoted by the line OC, 240° behind OB.

If we require the difference of potential $V_a - V_b$, existing between the extremities A and B of the star connection, we have

$$V_a - V_b = V_a - V_o + [-(V_b - V_o)]$$

and this relationship indicates that, to determine the resultant of any two of the three E.M.F.s, we must take one as a negative quantity, since in connecting the coils one coil is reversed when they are taken in pairs. Thus, in Fig. 7, I. OB is the negative vector of OB, and denotes $[-(V_b - V_o)]$, and the resultant $V_a - V_6$ is represented in magnitude and phase by the vector OD, and from the geometry of the figure it is clear that the triangle AOD is an isosceles triangle, and that the angle AOD = the angle ADO = 30°, and by dropping a perpendicular from A on to OD, we have

$$OD = 2\,Op = 2 \times OA \cos 30^\circ$$
$$= \sqrt{3}\,OA$$

and the value of $V_a - V_b = \sqrt{3}\,(V_a - V_o) = 1{\cdot}732$ E.M.F. generator in one winding. Again, the resultant OD is 30° in advance of the E.M.F. $(V_a - V_o)$. In other words, there is a phase relationship of 30° between the difference of potential $V_a - V_o$, and the difference of potential between the terminals A and B of 30° or $\frac{\pi}{6}$. Similarly, the P.D.s between the terminals B and C, and between C and A are given by the vectors OD_1 and OD_2 respectively, and we have for the three P.D.s

$$E_{ab} = E\sqrt{3}\sin\left(pt + \frac{\pi}{6}\right)$$

$$E_{bc} = E\sqrt{3}\sin\left(pt - \frac{\pi}{2}\right)$$

$$E_{ca} = E\sqrt{3}\sin\left(pt - \frac{7\pi}{6}\right)$$

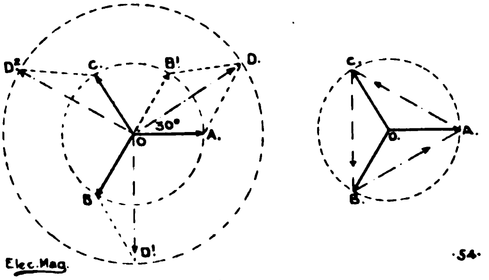


FIG. 7.

The same result is shown in Fig. 7, II., in which AB, BC, CA are respectively equal and parallel to OD, OD_1 and OD_2; and it is worthy of notice that the resultant of two equal E.M.F.s with a phase relationship of 120° is represented by the side of an equilateral triangle inscribed in a circle of radius equal to one of the components. The ratio between the P.D. between the pairs of terminals or slip rings and the E.M.F.s generated in the coils is 1·732 : 1, and the P.D. between the terminals in the case of the star grouping is 1·732 times the terminal P.D. of the mesh winding, other conditions being the same. As regards the current delivered to the line wires, it is obvious that the current is of the same intensity in the line wire as in the armature coil in the case of the star grouping, whilst the current in the line wires is 1·732 or $\sqrt{3}$ times that in the armature coils in the case of the mesh grouping, as will be obvious if the resultant of two equal currents with a phase relationship of 120° be obtained by the method just explained for finding the resultant of two equal E.M.F.s with a phase relationship of 120°. The star or Y method of connecting the coils is specially adapted for power purposes, whilst the mesh or Δ coupling is adapted for systems supplying current for both lighting and power purposes from a three-phase alternator, as there is not the same tendency to become unbalanced with this type of winding as is probable with the star grouping.

Although these methods of connecting the windings of three-phase machines have been considered from the generator point of view, it must be borne in mind that the stator windings of three-phase induction motors are interconnected in exactly the same way, and for the same reasons. If E be the difference of potential applied between any two terminals of a three-phase motor, then the difference of potential acting upon the respective windings is obviously E in the case where the coils are mesh connected, and

$$\frac{E}{\sqrt{3}} \text{ or } \frac{E}{1·732} \text{ or } 0·577\ E$$

in the case of the star grouping.

LONG-DISTANCE ELECTRIC TRACTION SYSTEMS OF THE FUTURE.

The following article, though relating specifically to electric traction, is inserted here as presenting in comprehensive terms the chief features of the electric railway problems now so prominently discussed in rapid transit circles. We refer our student readers to the Traction and Transport section for detailed information on the same subject.—[ED.]

IN THE early days of electric traction, the efforts of electrical engineers were directed mainly towards the solution of the numerous practical difficulties, some of them mechanical as much as electrical, which were encountered when an attempt was made to work tramway lines electrically. Among the most important of such difficulties may be mentioned the design of a suitable form of truck for supporting the body of the car, the mode of suspending or supporting the motors, the choice of a suitable form of gearing, the design of the motor itself so as to satisfy the special requirements of a traction motor, the method of starting and controlling the speed of the motors, the design of a thoroughly reliable brake, and last—but not least—of a suitable form of "controller," free from the sparking difficulty. All these problems may now be regarded as satisfactorily solved, and the credit of having accomplished this may justly be claimed by American engineers. Electric tramway practice has now become more or less standardised, and the thoroughness with which all its details have been worked out may be inferred from the universal commercial success of electric tramway systems, and the almost feverish haste with which all the more important towns are having their tramway and suburban railway lines "electrified."

But as the various problems presented by electric tramways became solved one by one, the hopes of electric traction engineers began to rise, and their ambitions to soar higher.

There can be no doubt that one of the problems of the immediate future which is now pressing for solution is some system of electric traction applicable to long lines—much longer than hitherto constructed. It is a problem which is engaging the careful attention of many electrical engineers, and is being worked out, both on the theoretical and the experimental side, by many earnest investigators. Probably it will be of interest to our student readers if we briefly indicate the efforts which are now being made to deal with this problem.

The standard system of electric traction is that in which series-wound continuous-current motors are used, and continuous current is supplied to the car at a potential difference of about 500 volts. Since this potential difference must be approximately uniform along the line, current is fed into the line, not at one end of it, but at a number of "feeding points," where the line is connected to special conductors known as "feeders," which serve as connecting links between the line and the generating station, and maintain the uniformity of the potential difference along the line. So long as power is generated at 500 volts, the cost of the feeders increases very rapidly with the length of the line, so that beyond a certain distance it becomes economical to generate power at a much higher p.d. (amounting to a few thousand volts), and thus reduce the cross-section and cost of the feeders. Present day standard practice in such cases is to generate three-phase alternating current at a high voltage, and to transmit this to a number of "sub-stations," where, after being transformed by means of "rotary converters" into continuous current, it is fed into the line. The cost of the sub-stations, although less than that of low voltage feeders, is still considerable, and would become very heavy in the case of a long line, as sub-stations a few miles apart would be necessray. Clearly, then, it is desirable in long distance traction systems to get rid of the heavy capital expenditure represented by converter sub-stations, and the only way of effecting this is to do away with conventers altogether.

This, however, involves the direct supply of current to the line at a very high voltage—a few thousand volts—and no continuous current motors can be constructed to work at this voltage. Consequently, the present standard 500-volt continuous current practice, with all its advantages, must be abandoned in favour of a high voltage system.

Briefly stated, there are two rival high voltage alternating current traction systems now awaiting trial. Experiments have already been carried out with each of them. The first is the three-phase system. It is in regular use on the Valtelina lines in Italy, where it has so far been quite successful, and it was the system employed in connection with the recent interesting high-speed trials on the Marienfelde-Zossen line in Germany, three-phase induction motors being employed.

The weakest point in connection with the three-phase system is the unsatisfactory performance of the motors, at any other than their normal speed, which is nearly that of "synchronism." There is no simple and effective way of controlling the speed, and the operation of starting is unsatisfactory.

The rival system, which, however, has so far been hardly given as extended a trial, is the single-phase system, employing, not single-phase induction motors, which would be even worse than three-phase motors, but ordinary series-wound motors, like those used with continuous currents, but having laminated fields. Until recently, the use of such motors was looked at askance, as they were known to possess numerous defects, the most serious one being the violent sparking at low speeds. At present, however, much attention is being given to their design, and already promising results have been obtained. It may be mentioned that as such motors could not be supplied at a high voltage, a step-down transformer would be carried on the car.

Among the latest experiments in connection with such single-phase series-wound commutator motors may be mentioned those recently carried out by Dr. Giorgio Finzi, in Italy, and those now in progress by M. Latour, in France. The latter experimenter has invented a series-wound motor of very ingenious construction.

The series-wound alternate current motor possesses the important advantages of a continuous-current motor of the same type—powerful starting torque and great flexibility as regards speed.

The future alone can decide which of the two rival systems will win the day. Meanwhile, it may be said that the single-phase system, employing series-wound commutator motors, holds out great promise of future usefulness.

SPECIAL TO STUDENTS.

An Ideal Institute.

Next month the Montefiore Institute, Liege, will be described, and illustrated with photographs exclusively supplied to this magazine.

Dynamo Design.

An instructive series of problems in dynamo design will also be commenced by one of the Associate Editors. Each instalment will be a complete problem in itself.

Mechanical Stokers.

These will form the subject of an important illustrated article in a succeeding issue. The subject will be specially dealt with by a prominent station engineer.

FROM PROFESSOR to Student.

Under this heading we shall deal with the queries of Students on matters directly relating to the science and application of electricity. Letters addressed to "The Associate Editor, Students' Section," should be received before the 1st of the month, if replies are needed in the next issue.

AMONG a quantity of other letters, we have received the following questions from a student reader:

1. What are the positions which an electrical engineer can hold?

2. What sort of duties does he have in the various positions?

3. What sort of openings are there likely to be for a student who has gone through a course of engineering at a technical college, and who has very little, if any, influence?

4. Is it necessary for such a student to be apprenticed?

(1) The number of branches of electrical engineering which demand a more or less specialised training is sufficiently great to suit a large variety of tastes. In addition to the older branches represented by land telegraphy, submarine telegraphy, telephony, and their special applications to railway signalling, we have the more recent forms of so-called "heavy" electrical engineering: the design and manufacture of generating and transforming machinery, of arc and incandescent lamps, of cables for the transmission and distribution of large amounts of power, of electrical measuring instruments; switchboards and switch-gear; central station work; the laying and maintenance of large networks of electrical mains; electric railway work; electric cranes and lifts; various special applications of electric motors, such as occur in connection with mining, the driving of printing machinery, textile machinery, &c.; and, lastly, the various branches of the rapidly growing electro-chemical industry—copper refining, the manufacture, by electrolytic processes, of caustic alkalies and bleaching-powder; the manufacture of aluminium and its alloys, of calcium carbide, carborundum, &c.

It is not always that an intending electrical engineer can choose for himself the particular branch of his profession in which he would like to specialise. So much depends on circumstances, and on what sort of openings happen to occur, that he frequently drifts into a particular line without having had any previous intention of doing so. But there are certain well-marked divisions between the more important branches of electrical engineering which, on account of the high degree of specialisation demanded in the more responsible posts, practically preclude a man who has made a special study of one particular branch from changing over to another. Thus, we seldom find a telegraph or telephone engineer taking up central-station work, or *vice versa*; nor does an electro-metallurgist easily turn from his subject to electric railway or tramway work.

(2) It may be said the duties of an electrical engineer are as varied as are the branches of his profession. Broadly speaking, however, his duties are partly technical, partly administrative. The duties, for example, of a designer of generators or motors are mainly technical; he has, in order to be successful, to master a vast array of the details relating to the special type of apparatus which it is his business to design, so as to combine the highest possible efficiency with the lowest cost of manufacture; he must be a trained experimenter, and possess the inventive faculty to a marked extent, so as to be quick at noting the results of various modifications in the design, and of taking advantage of such knowledge to introduce improvements; he must further be of a plodding, persevering nature, not easily discouraged by failure, and his mind must possess that quality of thoroughness which will prevent its resting satisfied until each problem has been followed out into its fullest and minutest details. On the other hand, the duties of a central-station engineer are entirely different, and are largely administrative. The plant is supplied to him by the manufacturer, and although he has the choice of the particular kind of machinery required, and must carefully consider its suitability or otherwise for the purpose in hand, he has nothing to do with its design. His business is confined to the proper care of the plant when once supplied, and to its most profitable use. The problems which present themselves to him are very largely commercial, such as the consideration of methods whereby the demand for power may be stimulated, the advisability of extensions, &c.

(3) and (4) We should like to emphasize at the outset that the success or otherwise of an intending electrical engineer is largely dependent on his own personality. The most carefully arranged course of training will only rseult in making a ghastly failure of a man who by nature is unfit for the profession. If, on the other hand, he has a genuine love for it, is prepared to undergo a good deal of hardship, and can thrive on constant hard work, he need not despair of success even if his means be slender, and he have no "friends at court." If he has received a good training at a technical college, but is unable to afford the premium which is demanded by some firms for a short apprenticeship course, he will probably find no difficulty in gaining admission as an "improver" to some electrical or general engineering workshop. In any case, a short apprenticeship course, extending over one or two years, must be regarded as an essential part of the training of an electrical engineer. Cases are not infrequent, however, in which young men fresh from college, succeed in getting appointments as, say, test-room assistants or draftsmen, at a small commencing salary of about £2 a week. It may be stated as a general principle, that the longer the time given to the preliminary training for the profession, and the time at which the young electrical engineer begins to earn his own living, the greater are his chances (other things being equal) of future success. A well-trained electrical engineer who regards his profession not merely as a means of livelihood, but as his hobby and his life work, need have no fear of ultimately finding a suitable opening (he must be prepared for a few discouragements), even if he has no influence.

MANUFACTURERS' Section

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be *original* and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

Competitive Estimates.

By W. NOBLE TWELVETREES, M.I.M.E., A.M.I.E.E., &c.

We have no doubt that our readers have frequently been amazed at the wonderful variations in the prices submitted by the various firms tendering for specified work. Sometimes, in fact, the lowest tender appears to be based on the assumption that raw materials and manufactured products can be obtained for nothing, or that the labour involved in carrying out a contract can be provided without the payment of wages. Numerous theories have been put forward from time to time to account for the vagaries of some estimating firms, but no satisfactory explanation has yet been forthcoming. Even if we disregard the wiring estimates of so-called "electrical engineers," who are willing to execute contracts for less than the cost price of materials, and of those who appear to rely upon "extras" for the purpose of more than making good the inevitable loss on the original contract, there is still much that requires explanation. Clerical errors and the miscalculation of quantities ought not to escape detection in a well-regulated establishment, but we fear they are sometimes to be blamed for exceptionally low figures. Excessive competition, again, may induce firms to base their final figures on utterly inadequate profits, and tempt them to omit necessary allowances for various contingencies, as well as for the cost of testing and maintenance. The difficulties of estimating so as to have a reasonable chance of securing business are very often increased by the terms of the specification, sometimes drawn so loosely that competitors necessarily make different estimates as to the cost of the work involved. At other times, specifications are so filled with arbitrary and unnecessary stipulations that those who have not carried out work for the consulting engineer are naturally apt to entertain more serious views of the question of prime cost than competitors who know the ropes. Perhaps the most unfair method of inviting tenders is that in which competitors are required, not merely to estimate the cost of the work, but also to formulate the entire scheme, from the outlined particulars furnished. The result is that several firms are obliged to devote time to purely professional work, for which not one of them but the successful competitor is paid. Moreover, the least satisfactory scheme is generally selected for acceptance because the price is morally certain to be the lowest. There are many features in the competitive system that are highly unsatisfactory, even when all the tenders submitted are carefully and conscientiously prepared on proper business lines. The matter is one of much importance to a large section of our readers, and we shall be pleased to hear any expression of opinion from them that may help us in the endeavour to protect their interests.

THE "G.B." SURFACE CONTACT SYSTEM.

In most of the surface contact systems hitherto introduced, the road studs, from which the cars derive their supply of current, project some distance above the general level of the paving, thus constituting a series of obstructions along the route that are both unsightly and dangerous. While in many cases the design of electrical details has received adequate attention, the axioms of road construction have been almost entirely neglected, and the insulating materials have generally proved to be not only unsuitable, but unable also to withstand the stresses caused by ordinary traffic. The "G.B." Surface Contact System, which we have recently had an opportunity of inspecting in actual operation, is the outcome of thorough collaboration between the electrical engineer and the road designer, and there has clearly been no attempt to enforce the requirements of the former at the expense of the latter. The most striking features of the system are its extreme simplicity, and the small number of working parts. The contact studs do not project above the level of the roadway and are in no way unsightly or objectionable. The principles of the system can readily be grasped, and any surveyor accustomed to dealing with the construction of roads and paving will find no difficulty in laying the track. It should be noticed that the cast-iron heads, in which the contact studs are placed, rest upon blocks of natural granite forming a solid basis which is not more liable to break or wear than the sets forming the remainder of the paving. The studs themselves project downward into a stoneware conduit in which the main conductor is carried on insulators. The conduit is laid in the concrete base of the paving and is thoroughly drained and ventilated, consequently the troubles due to undrained and unventilated stud switch-boxes are entirely avoided. One very important advantage of the system is the extremely low cost of installation and maintenance, and this is certainly a feature which entitles it to the favourable consideration of all interested in tramway enterprises. Current from the generating station is supplied through a bare cable passing along the conduit, and is conveyed to the cars through the studs, which are placed at intervals along the middle of the track. Connection between the cable and the studs is effected magnetically at the moment the car magnet comes over the studs, and ceases immediately it leaves them.

The following description, together with the illustrations reproduced, will enable the reader to follow the working of the system in detail.

The conduit consists of ordinary glazed vitrified 5 in. stoneware pipe, and at places where studs are required special branch pieces with the necessary outlets are provided. The other lengths of the conduit are merely plain butt-jointed pipes, a special bituminous joint being employed. Owing to the simple character of the conduit it can be laid at equal pace with the rails. The conduit is completely embedded in concrete, as seen in Fig. 1, which includes longitudinal and cross sections showing the general method of construction of the track and contact system. The total depth of excavation necessary does not exceed 19 in., and can be decreased by 6 in. or 7 in. if necessary when passing over bridges, pipes, or other obstructions.

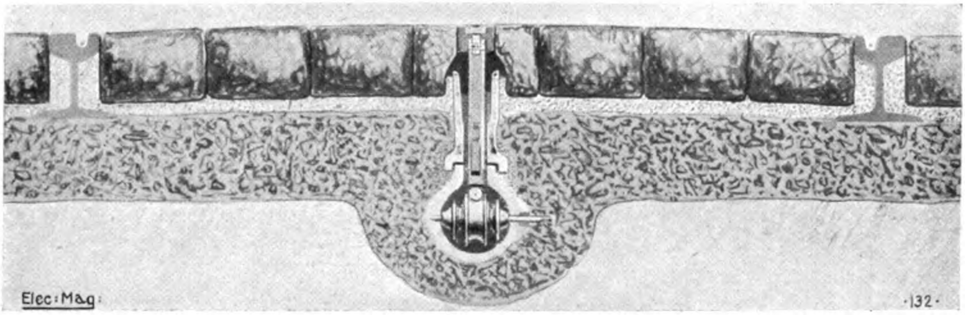


Fig. 1. Section Through Track and Contact.

It will be seen by the illustration that the mechanical strength of the design is ample to meet all the demands of heavy road traffic. The arch and invert formed by the concrete above and below the conduit forms a structure which is stronger than the ordinary 6 in. paving base. The insulators carrying the cable are of the finest insulator clay, thoroughly vitrified and glazed. The creeping surface is long and of constricted cross section, providing high insulation resistance. They are mounted on galvanised steel pins passing through the conduit on one side and into a stopped hole on the opposite side. The ends of the pins which project through the conduit are connected together by means of galvanised iron strip coupled at intervals to the rails.

This simple device affords an absolute guarantee that no stud can ever become "live" in consequence of leakage from the conductor. The complete immunity employed by this system from a defect which has been one of the greatest objections to surface contact systems generally, results from the fact that any current leaking from the conductor must pass into the pin on which the insulator is mounted, and thence through the connection to the rails, thus completely protecting the stud from leakage currents.

The service cable consists of galvanised iron wires stranded together, and where necessary, a copper core is inserted to increase the current carrying capacity. It should also be noted that the cable is of very inexpensive construction, and renewals can be cheaply effected should they become necessary in course of time. Access boxes, with cast-iron body and manganese steel cover, are placed at intervals of 200 to 400 yards along the track, and set in the paving in the usual way. Two sections of conduit enter the box on opposite sides, and the two cable ends are led to terminals mounted on insulators attached to the box. The boxes are fixed at the lowest points along the track, and, being provided with drain connections, any water finding its way into the conduit is at once removed. The studs are mounted in cast-iron heads, the top surfaces of which are level with the paving. Special attention is directed to the fact that the blocks supporting the stud heads are of natural granite, and consequently wear uniformly with the remainder of the paving, and are able to withstand the heaviest traffic. The shank of the stud, projecting downwards into the vertical pipe joined to the outlet of the conduit, is forked at the lower end and lined with brass. Within the fork is mounted the only moving part in connection with the electrical equipment of the track. This consists of a piece of iron protected with copper, suspended freely by means of an insulated phosphor bronze spring from the top of the fork, and carrying a renewable carbon contact block, the life of which is estimated at about four years. Flexible copper leads connect the moving part with the fixed part of the stud.

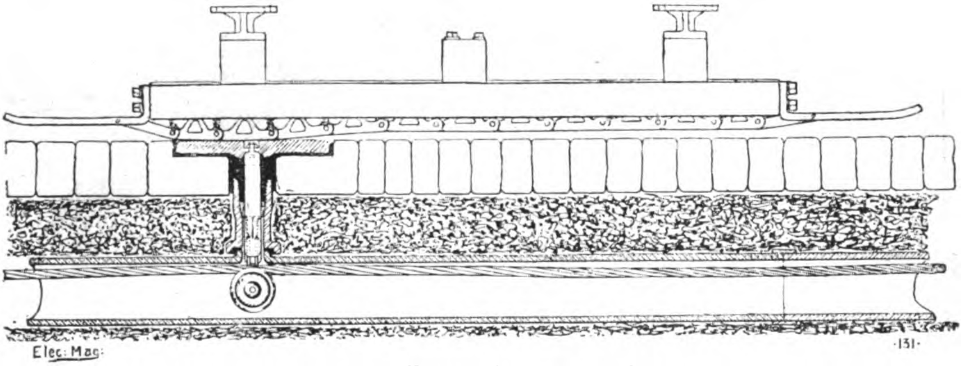


Fig. 2. Section Through Collector and Stud.

When the magnet carried by a car passes over the stud, the moving part of the latter is magnetically attracted towards the cable, against the pull of the spring, so that the carbon block comes into contact with the cable, and current passes to the stud, where it is collected by the car. As soon as the car has passed, the phosphor bronze spring withdraws the moving part from contact with the cable, and the stud is left absolutely dead. The joint between the vertical portion of the stud and the upright pipe by which it is sheathed, is made by filling the internal space with bitumen supported on a packing of jute yarn. The joint so formed is completely watertight, non-conducting, and sufficiently pliable. Bitumen is also run in round the stud heads, filling any spaces between them and their supporting granite blocks. Owing to this method of construction the stud is perfectly watertight, and in damp weather current loss only occurs over the road surface, the granite and bitumen around the studs being efficient insulators.

From the foregoing, it will be seen that the only moving part is of extreme simplicity, and, we may add, that it can readily be renewed without the necessity for disturbing the track in any way. The cable can be laid with very little trouble, and withdrawn at any time for inspection; and burnt patches can be moved out of contact by drawing the cable forward a short distance, or by turning it partly round.

Any ordinary car can be adapted to this system, the only modification required being the addition of a magnet, a few small accumulators, and the necessary wiring connections. The magnet is suspended rigidly from the car, as will be gathered from the illustration below (Fig. 2). The coils and battery are connected so that the current of the motors, when small, assists the battery in exciting the magnet, and, when large, also serves the purpose of re-charging the battery. Thus no special arrangement has to be made for battery charging, as the batteries are discharging and charging alternately.

The collectors are of novel and simple design, and collect current from studs level with the paving, in a manner which has never been approached in any previous contact system. They consist of iron tongues, spring-suspended within one pole of the magnet, and the lower ends of the tongues are connected by a chain-like arrangement of steel links. Their method of operation is as follows: When the pole of the magnet passes over a stud head, magnetic attraction causes the tongues to move down and make contact with the stud. As each collector reaches the end of a stud it is instantly drawn up out of contact with the road by the spring. As the magnet is itself mounted some two inches above the track level, it will be seen that with this method of collection the brushes ought to be able, under all ordinary circumstances, to avoid stones or other obstructions accidentally present on the roadway surface. No weight is applied to the stud during the passage of a car, and contact is caused without the slightest shock or jar. As a result of our personal examination of the experimental installation established by the G.B. Company at Ilford, we are in a position to say that all the conditions necessary for the highest economy and efficiency appear to have been duly complied with. The number of watts required for exciting the magnet is unusually low—not more than 325—owing to the fact that the collectors form a magnetic link between the magnet and the studs, and thus avoid a large drop of magnetic potential between the two. The method of collection involves no wear to the paving, and produces no measurable brakeing effect, as would certainly be the case if the magnet were used as a collector; and the insulation resistance of the supply cable is very high, being far superior to that of a slot conduit system, since dust and mud cannot accumulate upon the insulators.

As already explained, an entirely original safety device is provided by the insulator pin. The importance of this safeguard can hardly be overestimated. If a stud should be left live owing to any fault of the switching mechanism, a short-circuiting device carried by the car will cause an automatic cut-out to open, thus disconnecting the section upon which the car is running, but should the stud be live owing to leakage, no such action will take place, as leakage current is not appreciably increased by short circuiting the stud to the rail, and cut-outs or fuses in the circuit will therefore remain inoperative. With the present system, any such accident is physically impossible. The value of a device which totally prevents leakage to the stud is therefore at once apparent, and were this the only advance made it would place the system in the front rank.

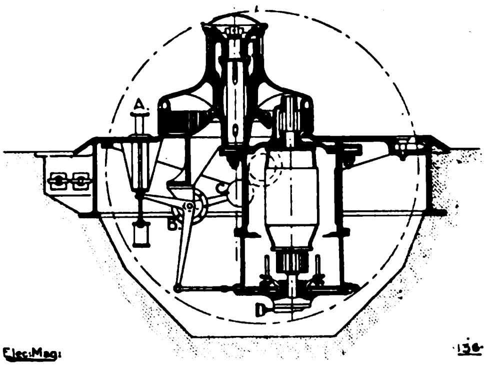
The car is provided at each end with a chain earthing device, which is intended to indicate whether any stud has been left alive after the car has passed. These earthing chains are connected with the rails through a resistance and an automatic switch, which will break the motor circuit and warn the driver that a stud has been left alive. It will then be the duty of the driver to go back, and, after locating the defective stud, to place over it a danger signal mounted on a tripod, warning other users of the road that a stud is alive. Each succeeding car conductor will have to remove and replace this tripod in order to allow his car to pass.

On the occasion of our recent visit to Ilford we found that with a single stud alive, the leakage current was only 0·25 ampere, and that with all the studs dead, the leakage current from the cable was not more than 0·025 ampere. Further, we were able to form the opinion that the leakage to earth should be far less than on contact systems using ordinary cables which have to be looped into boxes under every stud. With regard to the cost of construction it is claimed by the company that this will not be more than 10 per cent. higher than that of the trolley system, and that it will be only one-tenth of the conduit system as lately applied by the London County Council. The cost of maintenance should also be very low, for the life of the stud heads is at least equal to that of the rails, and the cost of renewing the stud heads throughout a mile of track (labour included) is said to be less than the cost of erecting a single line of 6 mm. trolley wire. The experimental track at Ilford has now been in operation for more than a year, sometimes under the most trying conditions. We learn that the Folkestone Corporation have already decided to adopt this system, for which we believe there is a great future.

ELECTRIC CAPSTANS AT THE PORT OF ANTWERP.

THE capstans at the port of Antwerp serve to actuate the transporters, by which wagons brought up to the back of the sheds on the Scheldt, are hauled to the quayside without having to pass through the sheds. Our readers may gain some idea of the large amount of work performed by these capstans from the statement that some of them make fully 1,000,000 revolutions per month. The installation is fully described in a paper read by M. P. C. Dufour before "L'Association des Ingenieurs Electriciens sortis de l'Institut Montefiore"; from the proceedings of which society the following notes are taken.

Some time ago the Haarlemsche Machinefabrik installed a number of capstans at the port, deriving current direct from the distributing network. The apparatus includes the usual starting resistances, and brushes attached to a counterbalanced lever and actuated by a pedal. When the pedal is released the counterweight returns the lever to its original position, and the circuit is broken. A contact is also provided which short-circuits the motor with a part of the resistance; the momentum of the armature and other moving parts, causing the motor to work as a dynamo, and thus provide a very efficient brake. To operate this machine satisfactorily the pedal must be depressed slowly to avoid a rush of current and blowing of the fuses or damage to the brushes. Having carefully studied the question of improvements, M. Dufour proposes to modify twenty-seven of the capstans already fixed on the quay. As these particular machines are all used for one branch of the service, and are actuated by motors of uniform type, they can be operated in series instead of in parallel. If the brushes of the motor are placed in the axis of a pole, the current will not cause the motor to revolve; but if the brushes are moved in either direction, torque will ensue, setting the motor in motion, and at one particular position the torque will attain its maximum value. The power of the capstan is in direct proportion to the angle at which the brushes are set, while the number of revolutions depends upon the load. M. Dufour believes that efficient control can be secured by the application of a pedal acting upon the brush carrier of the motor, and that the ordinary starting appa-



ELECTRIC CAPSTAN.

ratus can be altogether dispensed with. He calculates that if the twenty-seven capstans in question were simultaneously working at full load, the generator should supply current at a tension of (27 × 160) 4,320 volts, in addition to which an allowance of 100 volts should be made for loss for transmission. As a matter of fact, not more than one half of the capstans are in operation at any one time, and, if connected in series, the voltage furnished by the generator should be varied with the number of machines used. Therefore the problem for consideration was how to maintain constant voltage in a circuit of varying resistance. The solution was finally obtained by varying the number of revolutions of the generator, this being, in the case of the Antwerp installation, the most simple and economical method. For the purpose of effecting speed regulation, a steam engine of special construction is coupled directly to a series-wound dynamo, and, as the engine has a constant cut-off, the speed varies with the energy consumed. The drawing here reproduced represents the capstan as designed by M. Dufour and his colleague, M. Thury. The motor develops 18 h.p. at 450 revolutions per minute, using 100 ampères at 150 volts. In order to make connection with the brushes and the collector, three arms are provided, and in the casing is an opening through which passes a spindle, forming part of a rack. By a suitable lever, this last-mentioned part is connected with the pedal, A, so that when the pedal is depressed the brushes are shifted from the neutral line to the position corresponding with maximum torque. One arm of the lever is connected with the circuit-breaker, B, which, in its upper position, short-circuits the motor. As the lever is provided with a counterweight, C, the motor is short-circuited as soon as the attendant removes his foot from the pedal. The dash-pot, shown at the bottom of the pedal mechanism, checks the speed of the downward thrust, but has no effect upon the action of the counterweight. To ensure the immediate stoppage of the motor when required, the brushes, when in their position of rest, are slightly beyond the neutral point, so that when the pedal is released the motor is reversed, and the capstan is immediately brought to a standstill. To prevent "racing," the motor is fitted with an automatic by-pass circuit breaker.

◆ ◆

HIGH POTENTIAL SWITCHES.

FIG. 1 shows a three-pole, double-break oil switch made by the Hartman Circuit-Breaker Company, of Hansfield, Ohio, for installing on the back of a switch panel, and to be used on circuits up to 11,000 volts. The illustration shows the switches in the "off" position, with one switch enclosed in an oil tank. Each pole is immersed in a separate tank, which can be readily removed without interfering with the others. The tanks are lined with insulating material, formed in such a way that there is just sufficient space for the free movement of the switches, the quantity of oil used being thus reduced to a minimum. A feature of this switch consists in the use of the laminated, or brush, form of contact, which greatly increases current-carrying capacity and entirely prevents "freezing," or sticking, at critical periods. The contacts are protected by final arcing plates, which, with the corresponding plates on the terminal blocks, are removable, and can be readily replaced should they become burned away. The movable parts of the switch are controlled by wooden rods, fastened at their upper ends to a common cross-bar, and held in normal position by means of a toggle. In Fig. 2 the switch is shown with automatic over-load attachment, the distinctive feature of which is that the tripping coils are energized by current from the high-potential circuit, and series transformers are unnecessary. The tripping coils are mounted by means of special porcelain insulators on the carrying frame, being separated by barriers of insulating material. One of the most important features of the attachment is that it cannot be held closed while an over-load exists on any line. This apparatus is also constructed for remote electrical control, and in this case the operating current may be derived from any convenient source of direct-current supply at from 110 to 500 volts.

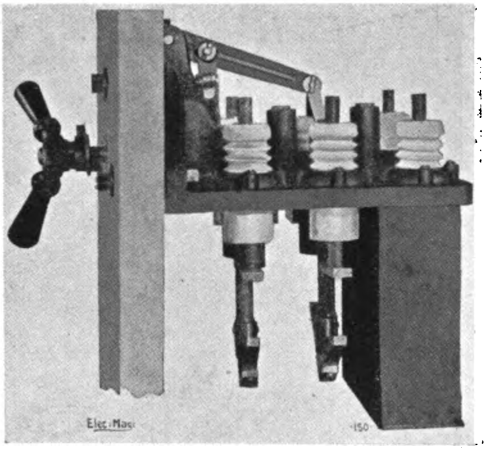


FIG. 1. H. T. OIL SWITCH.

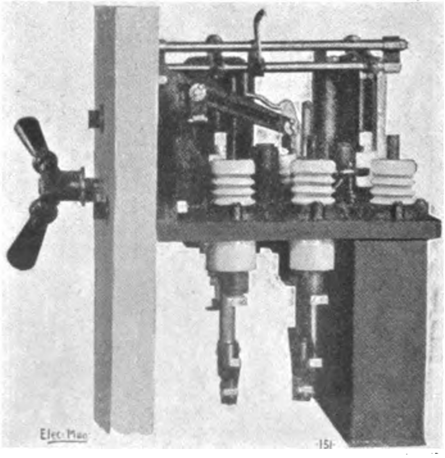


FIG. 2. OIL SWITCH WITH OVERLOAD ATTACHMENT.

THE HOWARD CONDUIT SYSTEM.

AMONG the many conduit systems for underground cables, that introduced by The Howard Conduit Company, of Trafford Park, specially deserves the consideration of consulting engineers and contractors. The conduit itself is manufactured from natural rock asphalt, a material admirably fulfilling the requirements of an electrical system of distribution. The process of manufacture consists in placing the hot asphalt in a mould, or sheet iron pipe, and revolving it rapidly. Under the influence of centrifugal force, the asphalt is compressed into a cylinder of uniform thickness, the heavier constituents forming a strong outer skin on the outside of the pipe, while the lighter matter forms a smooth inner surface. This method is applied to the manufacture of pipes suitable for drawing-in systems. Asphalt troughing is also made in over thirty sizes for the solid system, the troughs being composed of asphalt about ½-in. thick, covered on the outside by thin sheet iron, which acts as a mould in process of manufacture, and a protection during handling. The jointing of both pipes and troughs is performed by welding the joints together—a simple process resulting in a joint which is equal in resistance to any other part of the conduit. Howard's isolating system is another ingenious arrangement providing a safeguard against the stoppage of supply if the insulation of a cable should break down, and the entire avoidance of all damage by electrolytic currents. The manner in which this is effected is shown in Fig. 1, where D represents an asphalt lined joint box, connecting two length of lead-covered cable B, laid in asphalt trough A. The lead covering of the cable is insulated from the joint box by the asphalt, and connected to earth at E, through a resistance G, of 1 ohm, and an indicating fuse F, to blow at 25 ampères. The lead of the cables is divided up into sections at the joint boxes. As the only path from the lead covering to earth is through the resistance G and the fuse F, it follows that upon the failure of the cable insulation, the fuse will blow, and the lead covering will then be insulated from earth by the asphalt troughing. The position of any fault can be located by an inspection of the fuses in the various street boxes, without the necessity of making tests, or of interrupting the supply, and the cable can still be utilised until the fault can be made good. The resistance G reduces the electrolytic current to such a degree as to be quite harmless. The necessary fuses and resistances are supplied from one to three on a board and are fixed inside the drawing-in box for conduit systems, or in a water-tight pavement box for solid systems.

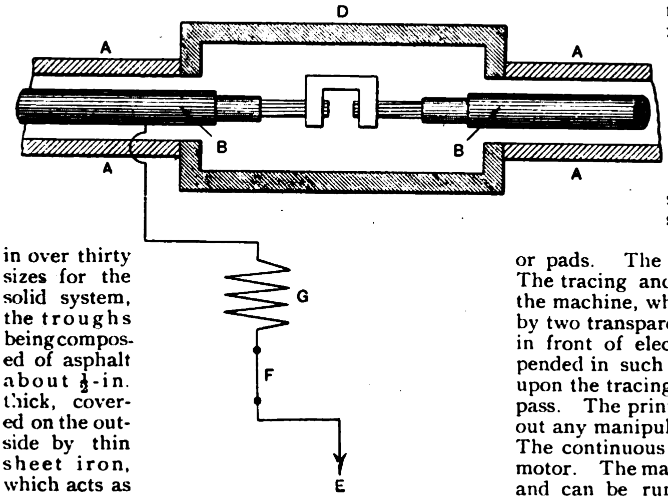


DIAGRAM OF EARTHING DEVICE.

A New Blue-Printing Machine.

A MACHINE, manufactured by Williams, Brown, and Earle, of Philadelphia, Pa., will make continuous blue prints of any length without stop or re-adjustment. The sensitised paper and tracing are fed in at one end of the machine, the print and tracing falling into a dark box at the other end. The tension is automatic, and the contact is perfect. A roll of blue-print paper can be run through continuously, and tracing after tracing laid upon it as it passes through without a stop; or separate sheets, of any size or shape, can be sent through without the use of curtains, levers, springs, or pads. The process of printing is very simple. The tracing and the sensitized paper are fed into the machine, where they are automatically clasped by two transparent continuous bands, and carried in front of electric lamps. The lamps are suspended in such a way that the light falls directly upon the tracing and the sensitized paper as they pass. The print is thus automatically made without any manipulation on the part of the operator. The continuous bands are actuated by an electric motor. The machine occupies a space 5 ft. square, and can be run on any 110 or 220 volt direct current, or 104 volt alternating current circuit.

A Novel Lamp Shade.

A NEAT form of lamp shade has recently been introduced by Mr. T. Parks, Nassau St., W.C., and from our inspection it fills a long felt want. With candle lamps and electroliers difficulties are always experienced in fixing or removing the shade without risk of breakage, no matter what care is taken. This device, however, quite dispenses with all the old troubles, in that the shade, which is of light fabric on a wire frame, is made in halves, held together by a spring. The pressing together of the top of the shade opens the lower half, and permits of it passing clear over the lamp, which, by the way, is not removed from the holder. We shall describe this device more fully next month, but meantime we refer our readers to the advertisement pages of this issue, where an illustration of the shade will be fonnd.

DUST DESTRUCTORS.

An article dealing concisely with the working results of dust destructors as applied to electricity works will be published in our next or succeeding issue. Tables setting out the actual cost of operation, will be included, together with valuable data supplied from the chief stations employing refuse consuming devices.

ELECTRIC COAL-CUTTING MACHINES.

The benefits to be derived from electric coal-cutting machinery are now thoroughly recognised by most colliery owners. The quality of coal has been changed by the use of such apparatus; so that, while the slack has depreciated, the round coal has very considerably improved. The following are among the benefits obtained from electric cutters :—

(1) More output per man employed.
(2) Coal economically worked that cannot be profitably worked by hand.
(3) More systematic working.
(4) Better round coal in almost all cases.
(5) Greater area exposed in the same time.
(6) Life Insurance Premiums reduced by one-third.

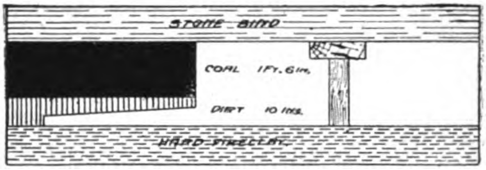


Fig. 2.

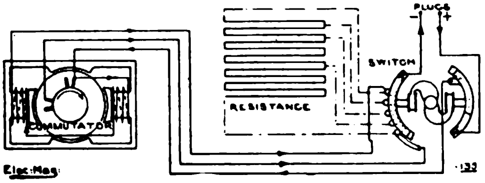


Fig. 3.

Among users of coal-cutting machinery, discussion is sometimes raised, however, as to the relative advantages of bar and disc machines. The Pickquick bar coal-cutter, made by Messrs. Mavor and Coulson, is one of the best examples of the former type. It has been urged that the relatively high speed of rotation is a disadvantage to the bar, as compared with the disc, type of machine, and that, consequently, the cutters wear out more rapidly. It is also thought that the bar may not be able to withstand the strains placed upon it, and may, therefore, be subject to frequent bending or fracture. Such objections as these appear to have no real basis. The higher rotating speed of the bar is really an advantage in an electrically driven machine, as less reduction gear is necessary, and, owing to the small diameter of the bar, the speed of the cutter is not higher than that of the slow running disc. With regard to the strength of the bar, experience has shown that damage of any kind is an extremely rare occurrence. The curves reproduced in Fig. 1 have been furnished to us by the makers, and were taken from actual tests under ordinary working conditions of the bar and disc machines, each holding 4 ft. 6 in. under in the same seam of hard fireclay, at 18 in. per minute. The irregular and interrupted lines show the unequal consumption of power of the disc machine, and the continuous line refers to the bar cutter. The advantageous features of the Pickquick bar cutter, over cutters of the disc type, have been repeatedly demonstrated in mines where both forms have been worked side by side, and we believe that the results here shown have been practically confirmed in many of the largest collieries in the country.

Figs. 2 is a typical section of a seam worked by the Pickquick cutter and speaks for itself. Fig. 3 is a diagram of the electrical connections of a D.C. motor resistance and switch for one of these cutters. The motor is of the four-pole shunt-wound type, the resistance being of iron wire wound upon flat slate formers, and the switch is of the quadrant type with contacts on a slate base. To reverse the direction of rotation, it is simply necessary to change the brushes to the dotted position in the diagram. Fig. 4 shows the connections for a three-phase motor auto-starter. The motor is of the induction type, with "squirrel-cage" rotor, and the auto-starter is a transformer reducing the initial voltage at the stator coils. The switch is of the controller type, having bridge-pieces mounted on a central insulated spindle. The direction of rotation is changed by reversing the face cable plug in its socket.

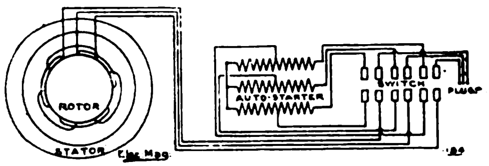


Fig. 4.

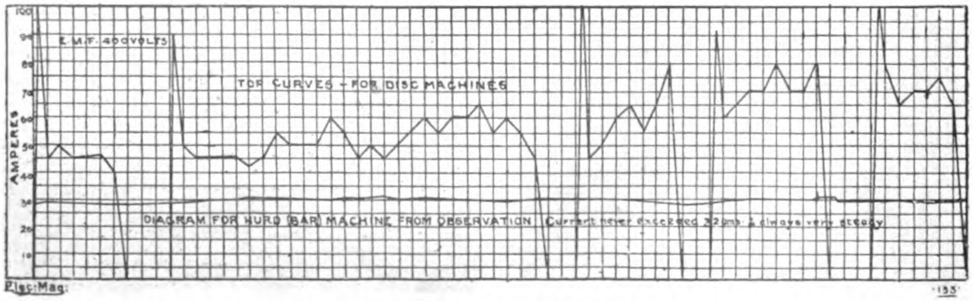
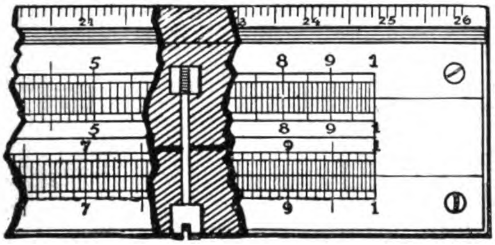


Fig. 1. Performance Curves.

A SLIDE RULE FOR HOT CLIMATES.

ORDINARY slide rules, even when fitted with steel backs, are always affected by atmospheric conditions, the slide becoming too loose in hot weather and too tight when the air is saturated with moisture. In the rule here illustrated the slide has a steel back, as shown at A, and the wood is slotted longitudinally from end to end. Further, three adjusting screws are provided, one in the middle and one at either end of the rule, by the aid of which the slide can always be made to travel easily and smoothly. This rule is made by Messrs. John Davis & Son, the well known instrument makers, of Derby.



SECTION OF RULE, SHOWING ADJUSTING SCREWS.

GERMAN THREE-PHASE TRANSFORMERS.

THE Allgemeine Electricitats Gesellschaft, of Berlin, have built three-phase transformers for many years. All their designs of capacities between 1 and 50 K.W. are oil-cooled, since more compact construction can thus be obtained than with air-cooling, and that oil-cooling conduces to increased efficiency and to diminish potential loss. Moreover, oil protects the windings from oxidation—a point which is insufficiently appreciated by many engineers. The cores are made up of thin iron sheets covered with paper, and the number of parts is restricted as far as possible. The smaller sizes have concentric windings, with the primary winding at the outside. In the larger sizes the windings are sub-divided into small coils, the high-tension and low-tension coils being placed alternately side by side on the core. Transformers for 10,000 volts are built altogether with concentric windings, but the outside high-tension winding is sub-divided into a number of small coils. As insulating material, specially prepared paper is used, with a thickness of 0·1 to 0·5 mm., several layers being placed above each other. A thickness of about 0·2 mm. will resist a tension of from 8,000 to 9,000 volts. The increase of temperature at the top of the oil bath is from 40 to 45 deg. C., and, in general, it takes about 15 hours of continuous operation before the maximum temperature is attained. The temperatures of the copper are at the highest from 8 to 10 per cent., and of the iron about 5 per cent. Three different types of A.E.G. polyphase transformers are made :—

Type A.D.O. up to 6,000 volts and for 1 to 50 kilovolt-amperes ;

Type B.D.O. up to 3,000 volts and for 1 to 52 kilovolt-amperes ;

Type C.D.O. up to 10,000 volts and for 5 to 50 kilovolt-amperes.

Fig. 1 is a diagram showing the efficiency percentage of the first-mentioned type in three different sizes.

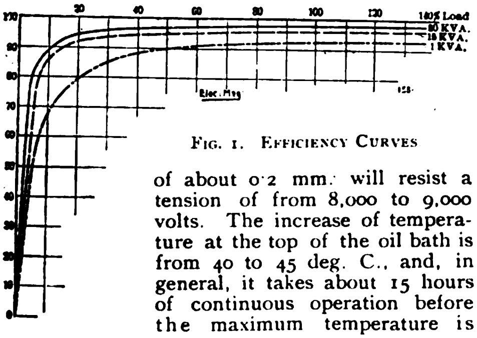
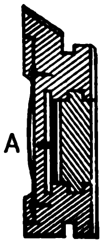
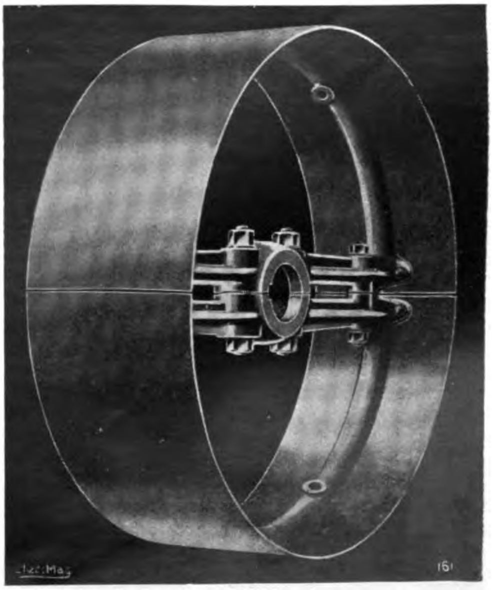


FIG. 1. EFFICIENCY CURVES

PATENT "RING" PULLEY.



WE illustrate herewith the ring pulley referred to in our catalogue section last month. With this pulley the boss, arms, and inner ring are cast in one piece. It is then split in halves, the irregularity of the fracture making a close and interlocking joint when the halves are bolted together. The boss is then bored and the ring turned on its face to afford a true surface on to which the wrought iron rim is riveted. It is found that the combination of the ring with the two arms and the close joint gives great strength combined with lightness, while the turned ring secures a true running pulley. The makers—The "Unbreakable" Pulley and Millgearing Co., Ltd., West Gorton, Manchester—are building all their pulleys of 10 in., 12 in., 14 in., 15 in., 16 in., and 18 in. diameter on this "Ring" principle, using two rings for pulleys over 10 in. wide. They claim lightness, strength, convenience, true-running and good appearance, as compared with either the cast iron or wrought iron pulley of ordinary make or with wood pulleys. A great advantage in the "Ring" construction is the absence of the air-fanning caused by the wide arms of the wood pulley. The Patent No. is 23970,1901.



RING PULLEY.

Central Station Practice

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

Fire Risks in Central Stations.

By the ASSOCIATE EDITOR.

THE fire risk in central stations has been shown by recent events to be greater than engineers have been willing to admit. It used to be said that, while works of the somewhat careless design of the eighties might suffer in this way, the precautions taken in those of recent erection had reduced the risk to an inappreciable quantity, if not abolished it altogether. But a visit to a number of stations does not inspire much confidence in the stability of supply in this aspect of the general question. The leads from generators to the switchboard are, for the sake of convenience, often rubber-covered cables protected externally by braid and compound. These are bunched—or, at least, left unprotected—and a fire is the inevitable consequence of an arc, of careless use behind or below the board of naked lights, or spontaneous combustion. If an attempt be made to tabulate the alleged causes of the fires at Croydon, Islington, Bristol, Salford, and other places, it will be found that faults in, or rupture of, volt-meter or shunt leads; spontaneous combustion; or transmission of flame, from an arc set up by other causes on the board, to the inflammable material on the cables, have been put down as the proximate source of all the trouble. Dust and dryness are two of the concomitant circumstances on a switchboard as at present arranged; and even the excellent types of gear devised by Mr. Wordingham for Manchester, and Mr. Chamen for Glasgow, do not touch the root of the difficulty, which lies beyond the gear and in the connections. Where lead-sheathed or armoured cable is employed on the connectors, or the specially manufactured "fireproof" conductors which one or two firms have put on the market, and the gear is mounted on fireproof frames, a great deal has been done. To bring conduit or gas barrel up to the switchboard is, perhaps, not altogether advisable, and one of the best means we have seen has been the provision of open-topped cement moulded ducts filled with sand, one cable only being laid in each groove. High tension or low tension seems to have little to do with the danger, it is the presence—open and exposed—of highly combustible material.

There is nothing more intimately associated with central station practice than maintenance of an efficient and regular supply. Leaving out of discussion for the time being interferences caused by purely mechanical defects in steam plant and generating sets, the station superintendent has always to face electrical breakdowns which take place without warning or giving any sign that would allow the charge engineer to be fore-armed. Noise and a drop in the lights are all that tell of the fault in at least half the instances that have been recorded. It is no simple thing to know which machine to disconnect, and the striking of matches and peering into ammeter dials once experienced is not likely to be forgotten. Automatic appliances are to be seen on most switchboards, and if the critical visitor looks a little closely, he will also find, probably, that the catch-pins are in position, rendering them inoperative. They are such nuisances when not wanted for their proper function that they seldom are available when they are called upon to act. Another feature which has to be improved is the principle of differentiation. Any such apparatus which relies upon shunt coils is weak; it becomes useless when the pressure on the omnibus bars falls. Its weakness is nevertheless, confined to this one condition, and at other times it serves a purpose not attainable otherwise. Mr. H. W. Clothier and Mr. Leonard Andrews have contributed valuable monographs to the literature of this department, and have set an example of the lines upon which it should be approached. Any of our readers who have had personal acquaintance with breakdowns and the circumstances attending them are invited to submit their comments, with a narrative of what took place, without mentioning the works concerned. We seek facts, not criticism of persons, but designs.

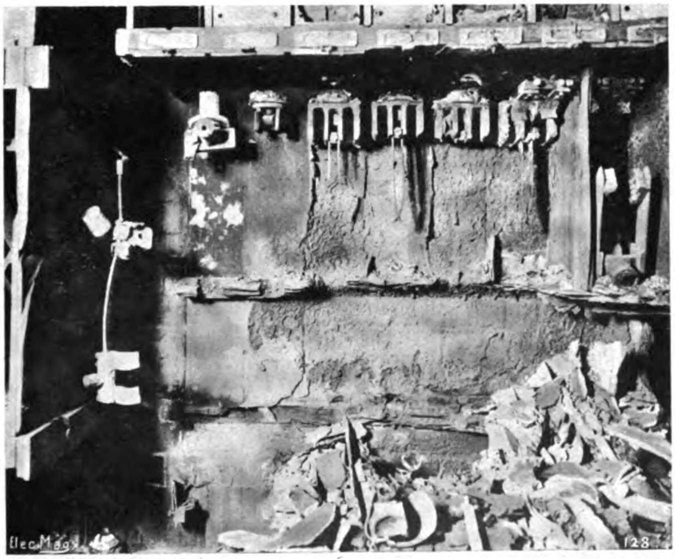


Photo Holmes.] BRISTOL SWITCHBOARD. THE CHIEF FIRE ZONE. [*Clifton.*

THE BRISTOL FIRE.

On this page and the next we present some interesting photos of the switchboard fire at Bristol, and the comparisons between the views taken before and after the accident are too marked for further comment on our part. The damage done in so short a space of time is ample testimony, were such needed, to the destructive effect of high-power arcs, even when apparently incombustible materials are used in switch-gear construction. While in no way criticizing the lay-out of the Bristol station, we cannot but feel that the extremely narrow gallery from which the board was operated quite prevented any quenching of the arc with sand from the front of the gear. Under favourable conditions certain daring spirits would have hazarded this remedy, which, even with all station lights out, could have been attempted with probable success in the flare of the arc.

THE CARE OF SWITCHBOARDS.

E. W. CREED.*

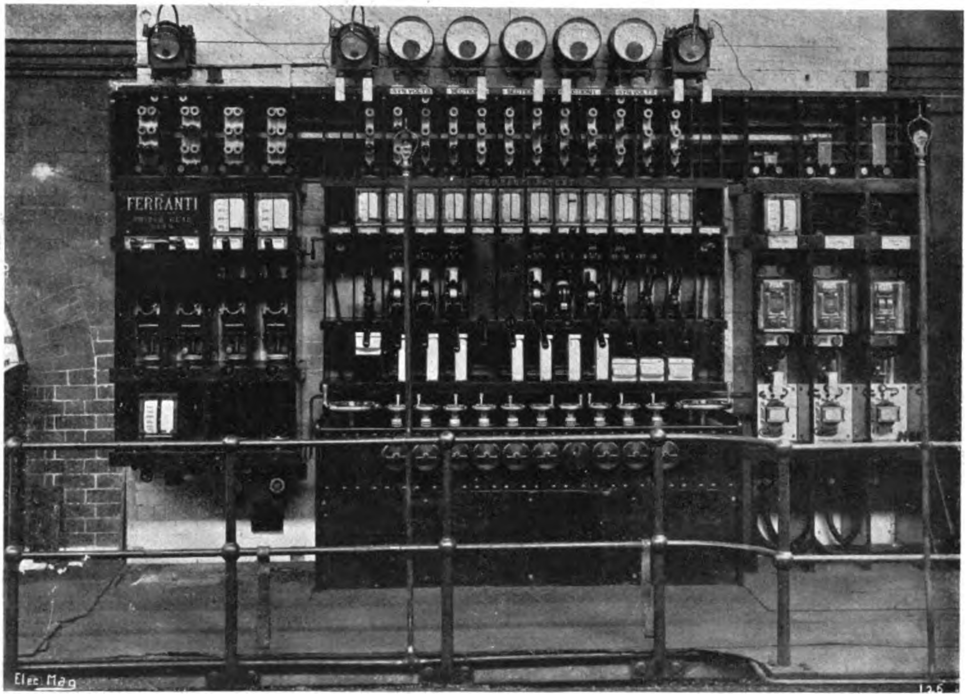
The circuit breaker is of first importance among all switchboard fixtures, and the "blow-out" type has considerable vogue. It is well known that with these circuit breakers the arc takes place in a strong magnetic field, but the principle of action whereby this effect is produced is a mystery to many. A wire carrying current, will, if in a magnetic field and free to move, tend to turn out of the field: further, a similar wire is surrounded by lines of force circling it in a definite direction depending upon the direction the current is flowing. An electric arc can be regarded as an extremely hot wire carrying current and surrounded by lines of force, which, if similar in direction, attract, while opposite lines repel each other. The coils of the "blow-out" magnet are wound to give two south poles at the front of the breaker and two north poles at the back. The iron plate, generally adorned with the name, capacity, etc., joins like poles, forming a consequent pole opposite where the arc takes place. A similar plate joins the back poles. Fig. 1 is an outside view of such a circuit breaker.

Fig. 2 shows the proper shape for the secondary contacts, and in the table below are dimensions for adjusting the various parts. The armature latch should be adjusted to allow the armature to be drawn down to a nearly horizontal position before it begins to pull on the latch. In this position the solenoid has much more power. More attention should be given to the spring if "blow-outs" occur too frequently. If the working parts become dry or gummed-up, 3 or 4 lbs. more pull on the armature is required than would be necessary to operate the circuit breaker if it were kept clean and oiled.

After several "blow-outs" on the breaker the secondary contacts become rough and burned. They should be taken out and filed smooth. The proper shape of both plunger and side contacts must be retained and a good idea is to work to a gauge made of thin metal. Filing the secondary contacts will alter their adjustment after a time: the plunger will then have to be raised and the side contacts moved closer together. The main brushes must bed firmly on the contact blocks, their

---

* *Power, N.Y.*



BRISTOL SWITCHBOARD BEFORE THE FIRE.

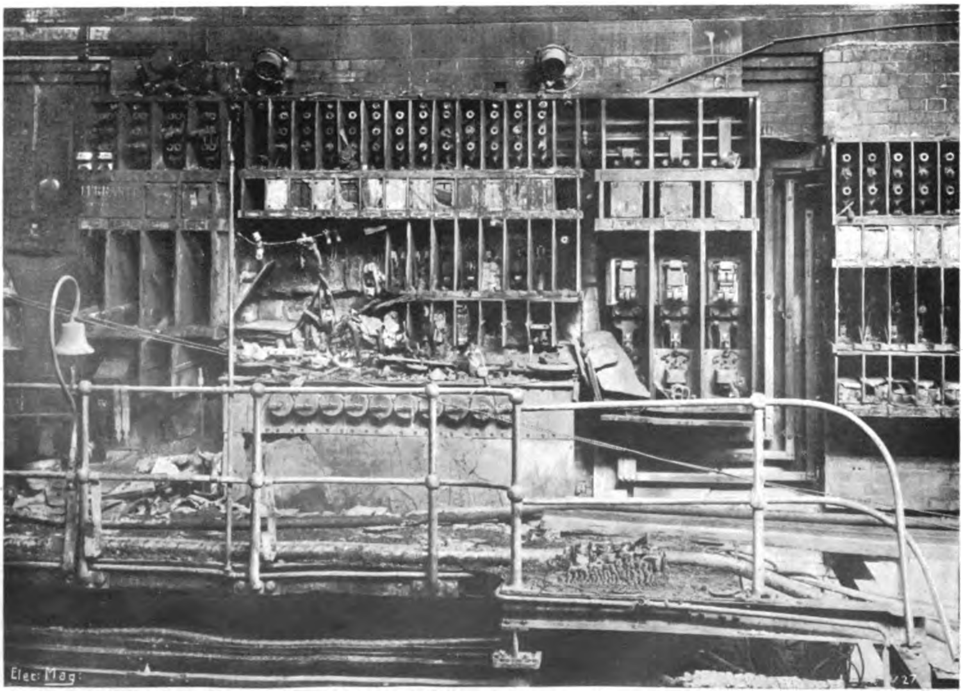


Photo Holmes.] BRISTOL SWITCHBOARD AFTER THE FIRE. [*Clifton.*

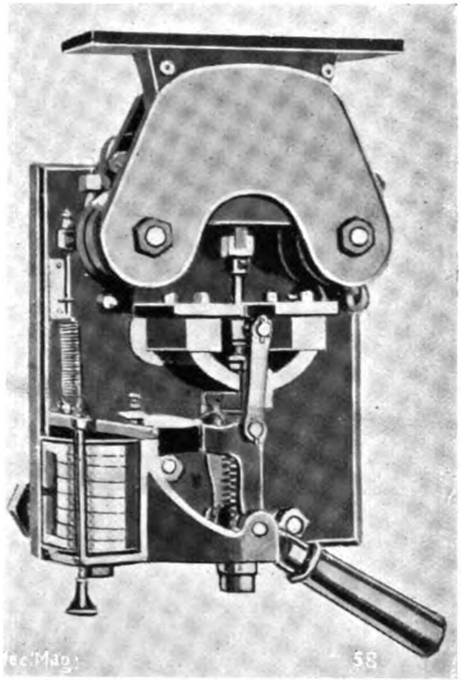


Fig. 1.

proper bearing being ascertained by the insertion of a piece of thin white paper and the closing of the breaker. An impression will be found on the paper showing where the brushes made contact.

The knife switches commonly used in series with magnetic "blow-outs" require some care. The joints should be screwed up just tight enough to allow the switch to drop slowly when opened about half-way. The upper contact should grip sufficiently to ensure a firm connection, but not too tightly. A little oil wiped on the joints and blades occasionally will ensure easy opening of the switch, but too much oil is not good. These switches should never be opened suddenly except in cases of emergency, but pulled out slowly to allow the spring to draw the bottom half of the plate out without striking the top half a heavy blow: such rough usage burrs the edges of the blades and prevents them making good contact.

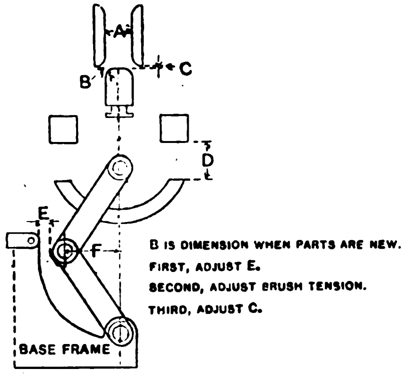
Occasionally a generator will refuse to build up. In this case, examine the rheostat switch and all connections, both on board and generator; if all appears right, close the equalising switches and positive switch on the generator building up. Current will then pass from the generator in circuit through the equaliser and series coil of the machine building up: this should remedy the trouble. The same thing can be done when it is required to run a machine up to voltage quickly.

The instruments require attention from time to time; but unless the switch-hand has exceptional knowledge and skill, he should not attempt any adjustments. These are better done by a competent man.

To prepare for emergencies or trouble, the switchman should plan his actions in case of certain failures, and instruct his assistants in their respective duties at such times.

Among other desirables, the line supply should be maintained at almost any cost. Especially is this so with traction and railway loads. Generators in parallel should be as evenly loaded as possible, and when a heavy pull occurs, they will all bear the strain equally. The opening of one machine circuit breaker may quickly be followed by all the others. At this juncture, it may be noted that should a breaker stick and arc badly, it should be saved from destruction by smartly opening its knife switch. Although serious burning may be the result of such action, the man who knows his work, and has the interest of the plant at heart, will act promptly regardless of the risk incurred. As an alternative, the generator switch may be opened, but the line will be left without power.

Again, in closing a switch on a "short circuit," don't look at the circuit breaker, but turn the head away, as this observance may save a burned face. The feeder alarm bell and its connections should be always looked to, as a breaker will often come out without noise.


A
B
C
D
E
F
BASE FRAME
B IS DIMENSION WHEN PARTS ARE NEW.
FIRST, ADJUST E.
SECOND, ADJUST BRUSH TENSION.
THIRD, ADJUST C.

AMPERES	WIDE OPEN					CLOSED	WHEN SEC. CONTACTS TOUCH
	A	B	C	D	E	F	G
300	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{32}$	$\frac{5}{8}$ to $\frac{3}{4}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{7}{16}$ to $\frac{1}{2}$
500	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{2}$		$\frac{3}{8}$ to $\frac{1}{2}$	1
800	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{2}$		$\frac{3}{8}$ to $\frac{1}{2}$	1
1200	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{2}$		$\frac{3}{8}$ to $\frac{1}{2}$	1
2000	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{2}$		$\frac{3}{8}$ to $\frac{1}{2}$	1

Elec:Mag .55.

Fig. 2.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike, which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

⁂

Making Small Commutators.*

THE making of a satisfactory commutator by the usual methods is a very unsatisfactory operation, if not a dismal failure, when done by the amateur or experimental electrician. The sketch shows a very simple method of which a brief description is given. Take a piece of ingot copper, forge a blank large enough to finish as per Fig. 1, bore and rough turn. Place it on a mandrel and mill the slots, going around with three cuts, with a slitting saw 1-32 inch thick. Let the first cut be a shallow one, and use plenty of lard oil on the cutter. With a sharp cutter and plenty of oil it will be found that copper saws as true and easily as any other metal. The second cut should go about half-way through, and the third within about 1-32 inch of the mandrel. After removing from the mandrel, cleanse thoroughly with gasoline. Next cut the sheet mica board squares to insulate the segments. These should be 1-16 inch wider and ⅛ inch longer than the slots. Sheet mica board may be bought 1-32 inch thick to just fill the slots. Shellac the slots and mica, using thick shellac, and fill the slots as in Fig. 2. Bake the whole over any fire until the shellac is thoroughly hard, and then turn off the surplus mica and put on a binding ring as in Fig. 3. The commutator is now ready to finish boring and turning the dovetails. Chuck, bore and finish one side as shown in Fig. 4, and then rechuck and finish the other side as per dotted lines of Fig. 4. In boring, the shell that holds the segments together is cut out, leaving the segments and mica all finished, assembled and held temporarily until the final assembling by the binding ring. Fig. 5 shows the detail of the commutator bushing which may be made of any metal desired. The dead black lines in Fig. 5 represent the mica insulation between the bushing and the copper segments, which is made of flexible micanite board 1-32 inch thick, and which can be readily bent into any shape by heating slightly. Fig. 6 shows the commutator complete after assembling and taking the final outside finish.

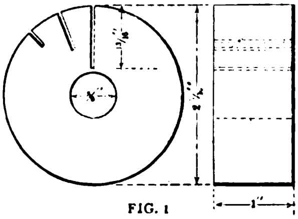


FIG. 1

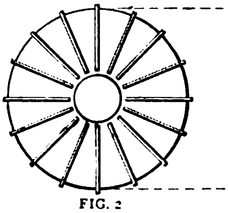


FIG. 2

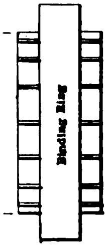


FIG. 3

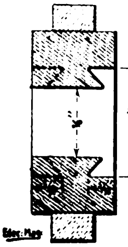


FIG. 4

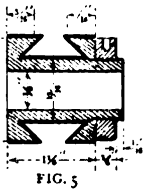


FIG. 5

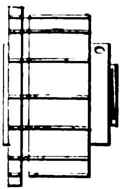


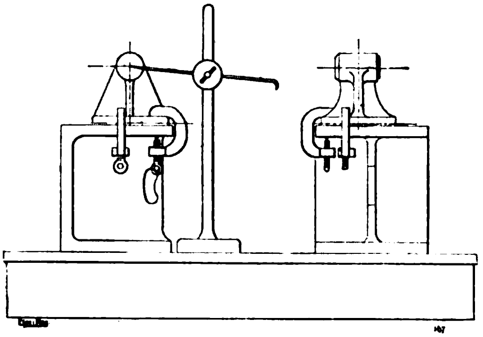
FIG. 6

---

* American Machinist.

HANDY ANGLE PLATE FOR LAYING OUT WORK.*

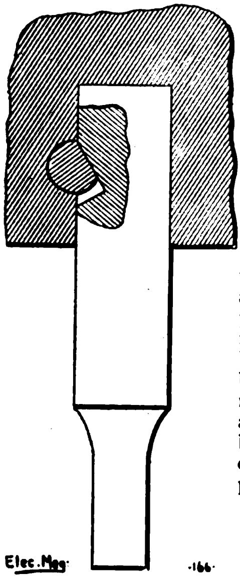
The sketch shows a handy "knee block" with a piece of work clamped on ready for marking off. This block can be made in different sizes; and it is machined up true on all outside faces, so that whichever face is turned down on the surface plate the other faces will be square with it. The hole cored in the centre rib is for convenience is handling. The piece, when clamped on as shown, is rigid to work at, and when one lot of lines are scribed, the block can be turned down on another face, and other lines put on at right angles to those already scribed. This saves lots of time, as there is no squaring up to be done, and no bother with bits of packing and wedges.



* * *

TO HOLD ROUND PUNCHES.*

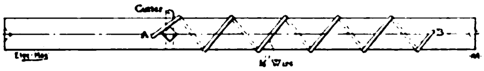
The sketch shows a good way of holding round punches. Set-screws are not very reliable and are a constant source of trouble. When the block is bored for the punch a straight round cross hole is drilled, cutting into the punch hole nearly one-half its diameter. A pin of cold-rolled steel is used that just fits this hole. The pin is tapered off, beginning with a very little flat at the head and cutting away, say, two-thirds of the diameter at the other end, and the punch has a bevelled notch cut in as shown. When the pin is put in, both it and the punch will roll until the flat surfaces adjust themselves to a bearing, and then a little driving will hold the punch securely.



* * *

A SELF-CLEARING BORING BAR.*

In boring some 3 x 24 inch cylinders, the most suitable tool for the job was a 16-inch Hendey lathe. The castings had been cored 2½ inches, and the bar was just small enough to pass through the hole, and carried a single ended cutter. The first casting was bolted to the carriage and the bar driven between centres. The first cut of ⅛-inch had gone only about quarter of the way when the chips began to pile up at the bottom of the hole to such an extent that the bar was bent upward, and the stock was all removed from the top and none from the bottom, the hole becoming more eccentric as the carriage advanced. The man (a good one) who was running the lathe sized up the situation in a moment, stopped the lathe, took out the bar, drilled two ¼ inch holes, as indicated at A and B, drove the end of a piece of ¼-inch Bessemer wire into hole A—which was a little in advance of the cutter—wound the wire tightly round the bar in a left-hand spiral till hole B was reached, then bending the end of the wire at right angles, drove it into hole B, and replaced the bar in the lathe. After this no trouble was experienced, the wire spiral removing the chips as fast as they were made. Since then the same rig has done service for both rotating and stationary bars.



* * *

LACING A BELT.†

The lacing of a 12-inch belt, using ¾-inch lacing, is described herewith. Square the two ends. Draw two pencil lines 1 inch and 2 inches from the end. Mark for the first hole on the first line at ¾ inch from the edge, the rest of them 1½ inches apart. On the second line lay off the holes at 1½ inches apart. This makes eight holes for the first lines and seven for the second. Begin by passing the lace singly, as shown in Fig. 1. Temporarily fasten the end at *A* and draw up the lacing tight and even to *B*. Then pass the lace by the end and up at 1, down at 2, up at 3, and so on across the belt. Then loosen the end at *A* and pass it as before, down at 1, up at 2, down at 3, and so on. These ends fasten themselves without knots, and a lace can be used over again.

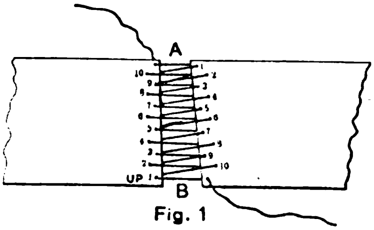


Fig. 1

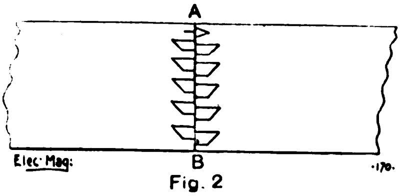


Fig. 2

---

* American Machinist.

† Power.

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrcial trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

Electrical Combinations in Germany.

By the ASSOCIATE EDITOR.

Recent developments in the electrical engineering industries of Germany cannot fail to be of interest to our readers, because they threaten largely increased competition from that country. The movement to which we now refer aims at the consolidation of the industry in the form of a few powerful groups. The magnitude of the German electrical industry is made clear by the fact that the twelve leading companies represent a share capital of some £20,000,000 sterling. Further, four of the works that have recently been combined into two groups share about three-fourths of the total electrical trade of the country, and are financially supported by the leading banks of Germany. The first step was the amalgamation of the Allgemeine Elektricitats Gesellschaft and the Union Electricity Company for a period of thirty-five years. The arrangement provided, moreover, for the conduct of manufacturing operations in such a way as will largely decrease the cost of production. This combination, representing a capital of over £4,000,000, was followed by the combination of the heavy electrical branches of the Siemens-Halske Company and the undertaking of the Schuckert Company, under the title of the Siemens-Schuckert Works Company, with a capital of £4,500,000. Beyond these combinations we find that the Berlin Accumulator Company is now proceeding to absorb the Pollak Accumulator Company of Frankfort; the Bitterfield and Rheinfelden Electro-Chemical Companies are about to join forces; and the Berlin Electric Light and Power Company is taking over the undertaking of the Cologne Company for Electrical Investments; while the Lahmeyer and Helios Companies, with a joint capital of £2,000,000, are reported to be on the verge of amalgamation. The whole of the combinations here mentioned have been formed largely for the purpose of reducing expenses, and at the same time of cheapening the cost of manufacture, and there is every reason to believe that the movement will continue to extend. British manufacturers will, therefore, be wise in making preparations for severe commercial rivalry in the immediate future, from huge associations having exceptional facilities for economical production, and almost unlimited financial resources.

ELECTRICAL PLANT WANTED IN EGYPT.

There is a constant and ever-increasing demand in Egypt for electrical machinery, apparatus, instruments, tools and fittings. Cairo and Alexandria have long been served by electric tramways, and the latter city is now extending its electric system over the railway line connecting it with the suburb of Ramleh. It is gratifying to know that the greater part of the material and rolling-stock has been supplied by British firms. The car-trucks, bodies, and motors, the cables, trolley-wires, and steel crossings all come from England, and we learn that the railway company is ready to place an order for 1,000 tons of steel rails for electric tramways with an English firm on receipt of a reasonable offer. The generators and power-house machinery were, however, furnished by Messrs. Brown, Boveri & Co., who tendered at a price far below those of British firms. Swiss manufacturers are best known in Egypt for the production of dynamos, and, although those of British manufacture are extensively used, there appears room for more active competition from British manufacturers, such as has already been forthcoming from German firms. In engines of all kinds, Great Britain has, on the other hand, practically enjoyed a monopoly for many years. But Switzerland, France, and Germany are now pushing trade most energetically. The steam engines turned out by Messrs. Sulzer Brothers, of Winterthur, are steadily supplanting those of our own makers, owing to their superior fuel economy and higher finish, in spite of their higher price. We direct the serious attention of manufacturers at home to this point, and desire to add the suggestion that personal representation in Cairo is the only effective means of securing the Egyptian market.

HOME TRADE NOTES.

Marine Electrical Work

Messrs. W. C. Martin & Co., of Glasgow and London, have just secured a large contract from the Allan Line Steamship Co., Ltd., for the electric installations on their two turbine steamers, at present building at Belfast and Glasgow. The plant for each vessel will be capable of furnishing current for 4,000 8-c.p. lamps, as well as for ventilating fans, motors for various purposes, and a complete system of electric bells.

During the past year about 30 steamers have been fitted with electric light by this firm, the fittings being of their well-known "Triton" pattern; and in addition to lighting appliances many of the steamers have been equipped with electric motors and fans for ventilating saloons, state rooms, holds, and cattle decks. It is interesting to note that electric motors and fans are now being applied for circulating warmed air throughout the rooms of passenger steamers. The air is driven by a fan through tubes in a steam-heated tank, where it is raised to the desired temperature, and distributed thence to the various rooms. This system has been proved to be much superior to heating by steam pipes. In passing through warm climates the air can be cooled by supplying the tank with cold brine from the refrigerating plant. In hot climates this system is of great comfort to the passengers, and is also valuable for the preservation of food. Over 20 large vessels have been fitted with electric light, heating and ventilating installations, during the past year by Messrs. Martin & Co.

Water Power Plant for Elgin.

A scheme now before the Town Council of Elgin, N.B., provides for the construction of a power dam on the River Lossie for the lighting of the district. The plant proposed includes two turbo-generators for the supply of three-phase alternating current at 5,000 volts. The volume of water available is estimated by Mr, D. J. Russell Duncan, the electrical engineer to the Council, at 1,630 cubic feet per minute, and it is believed that sufficient power will be furnished to maintain 60 arc lamps and 10,000 8-c.p. incandescent lamps.

Our Foreign Trade:

Fairly Satisfactory Figures.

Although depression has existed in certain branches of industry during the past year, the total commerce of the country, as indicated by the Board of Trade Returns for 1903, shows a fairly satisfactory increase. The value of the imports over that of the preceding year increased by £14,500,000, and that of the exports by £7,400,000. Dealing first with imports, we notice that, as compared with 1902, there has been an increace in the value of iron and steel and their manufactures, but a considerable decline has taken place in other metals and manufactures, and also in machinery. On the other hand, exports of metals and manufactures thereof, and machinery, indicate considerable progress, but this is nearly counterbalanced by diminished exports of new ships and telegraph cables and apparatus. The reduced figures in the case of cables and apparatus is due to the competition offered by other nations in this particular branch of trade, and which has already invaded the home market. Notwithstanding the encouraging nature of the figures, it will most probably be found that the progress made in this country has been proportionately less than that in the United States and Germany, which are now competing more keenly than ever with British manufacturers both at home and in other markets.

Extensions at Coventry.

An Opening for Manufacturers.

The Coventry Town Council are applying to the Local Government Board for sanction to borrow £31,575 for various extensions recommended by the Electric Light Committee, in accordance with the Report of Mr. Jeckell, the Borough Electrical Engineer. This report provides for expenditure on the following items:—

Transformers	£3,000
Services to consumers, with meters, etc. ...	£3,000
New generating plant	£11,575

The sum of £2,000 has already been spent in connection with the hiring out of motors, and an additional £5,000 is also to be devoted to the same purpose. Motors representing 500-h.p. have been connected within the last twelve months, and orders received for others aggregating 200-h.p. When the extensions are complete the capital invested in the station will be £150,000, the output 1,500 K.W. at a cost of 1.44d. per unit.

Belliss Engine Contracts.

The following are among recent contracts secured by Messrs. Belliss and Morcom, Ltd.:—

G.W.R., Park Royal, Acton (Electrical Construction Company), eight 1,100 h.-p. engines for coupling to E C C. generators; two 250 h.-p. engines for coupling to E C.C. dynamos; four condensing plants to deal with the exhaust steam from above. Royal Navy (Secretary to the Admiralty), seven engines coupled to E.C C. dynamos for H.M S. "Formidable," "Implacable," "Irresistible," "London," "Bulwark," and "Venerable." (Messrs Laird Bros., Ltd.), three engines coupled to Siemens dynamos for H M.S. "Lilley," "Moy," and "Ouse." (Messrs. Hawthorne, Leslie & Co., Ltd.), three engines coupled to Siemens dynamos for H.M.S. "Boyne," "Doon," and "Kale." Grove Hospital (Metropolitan Asylum Board), one engine coupled to Siemens dynamo for Grove Hospital. Todmorden (Messrs. Bruce, Peebles & Co., Ltd.), two engines for coupling to Peebles dynamos. East London Harbour Board (Allgemeine Electricitäts Gesellschaft), four engines for coupling to A.E G. generators. East London Municipality (Messrs Dick, Kerr & Co., Ltd.), two engines for coupling to English Electric Co. generators.

Extension of Electrical Plant in Whitechapel.

THE Stepney Borough Council are now seriously considering the expenditure of nearly £80,000 in the extension of their existing electrical installation at Whitechapel, which, it appears, is now quite inadequate for the heavy demands made upon it.

Telegraph Cables and Apparatus.

THE value of telegraphic cable and apparatus exported from Great Britain in the year 1903 amounted to £1,808,136, which should be compared with £2,838,641 for 1902, and £3,147,985 for 1901. The imports of the same class of products for the year 1903 were to the value of £57,360, while in 1902 and 1901 there were no imports. Here is one more sign of the invading foreigner in our defenceless markets.

A New Manufacturing Installation.

THE International Electric Engineering Company, of Clun House, W.C., are now engaged upon the complete equipment of new works at Peterborough for Messrs. Werner, Pfleiderer & Perkins, Ltd. The plant consists of a number of electrically-driven overhead travelling cranes, electric locomotive motors, generators, switchboards, and auxiliary appliances. The company have already carried out an installation of generators and motors at the London works of the same firm.

Progress at Fulham.

THE Borough Council have decided upon the construction of three new sub-stations at an estimated cost of £1,800, and an extension of the mains in Crabtree Lane, at an approximate cost of £1,000. Further, the Borough Electaical Engineer is preparing a Report relative to the conversion of the lighting in side streets from gas to electricity, and it is probable that a commencement will be made with some 300 lamps. Since last March the number of consumers has increased from 650 to 1,020, and the weekly output of the station has been doubled. The motor load has also shown gratifying progress, having been increased from 40 h.-p. in March, 1903, to upwards of 300 h.-p. at the present time.

NOTES ON FOREIGN TRADE.

German Electrical Industries.

DURING the year 1898 the output of electrotechnical products in Germany amounted to £11,433,500, of which fully £2,850,000 represented export trade. In 1902, the total exports of such products rose to nearly £5,000,000, although the total production of the country decreased considerably in the same year. It appears that many of the enterprises, such as electric railways, tramways and lighting plant, inaugurated and conducted by the electrical manufacturing firms in Germany, have proved unprofitable, and a large proportion of them have been abandoned. Our readers should note the fact that the manufacturing companies are now of the opinion that local enterprises of the kind had better be left alone, and that their proper policy is to concentrate all their energies upon export trade.

General Electric Company, U.S.A.

WE learn that, although there was a considerable falling off in the business of this company during the latter months of 1903, it is expected that the results for the year ending January 31st will prove to be fully as favourable as those of the previous year. In spite of the general depression of business in the United States, the company believe that their gross receipts will be nearly as large as in 1902, and that owing to the reduced price of copper and other materials, the net profit will come out very well. In connection with this firm we may mention that an order for 300,000 incandescent lamps has been booked for lighting the building of the St. Louis World's Fair.

Germano-American Co-operation. A Startling Development!

IT appears that the Allgemeine Electricity Co., of Berlin, has concluded agreements with the European branch companies of the General Electric Co., the Curtis Turbine Co., Profs. Riedler and Stumpff, and the German Inventions Introduction Co. These covenants bring into immediate operation the agreement entered into between the Berlin Allgemeine Electricity Co. on one hand, and the General Electric Co., the Fort Wayne Electric Works Co., the Stanley Electric Manufacturing Co., the Eddy Electric Corporation, the General Incandescent Arc Light Co., and the Northern Electric Co. on the other. As a result of the agreements, the United Steam Turbine Co. has been formed in Berlin to acquire and to exploit the Curtis and the Reidler and Stumpff turbine patents. Moreover, the relations established with the leading American electrical company involve considerably more than the friendly avoidance of competition with the European Thomson-Houston manufacturing companies. They mean active hostility, and an important step in this direction is the promotion of rivals to the Parsons steam turbine.

United States Electrical Exports.

THE electrical exports from the United States for the month of November, 1903, amounted to the value of £142,607. This shows a very small increase over that of the previous year, when the total value in November was £142,432. The figures may be classified as follows:

	1902	1903
Electrical Machinery	£86,267	£73,406
,, Appliances	56,164	69,201

Thus we see that electrical machinery has fallen off to the amount of £12,861, while electrical appliances (including telegraph and telephone instruments) have increased £13,037. November exports show a falling off, as compared with those of October, by a decrease of £26,249. The following were the heaviest buyers of American electrical machinery for November, 1903:—British North America, £22,668; United Kingdom, £18,972; Mexico, £8,219; Japan, £4,187; British Australasia, £3,718; British East Indies, £3,293; British Africa, £2,260; Philippine Islands, £1,685; France, £862; Cuba, £659; Hong Kong, £405; Germany, £347. Our readers should compare the figures for the United Kingdom with those for Germany. They teach a lesson!

Power Transmission in Mexico.

From recent advices we learn that Mr. H. H. Filey, chief engineer of the Guanajuato Power and Electric Company, is now at Zitacuaro for the purpose of preparing a scheme of power transmission between that place, where there is said to be abundant water power, and the El Oro district, the most important mining centre of Mexico. The Guanajuato Power and Electric Company last month completed the construction of their 60,000 volt power transmission line between the River Douro and the Guanajuato mining district, a distance of some 120 miles. Another Mexican project is for the construction of a large hydraulic plant between the city of La Barca and the Ateguiza hacienda on the Santiago River.

Street Lighting Tenders for New York.

Some trouble is now being experienced by the municipal authorities of New York in connection with the lighting of that city. All the lighting tenders except one have been rejected, and it is stated that the companies will have to sue for the lighting done during the past year, unless they consent to a considerable reduction in their accounts, the contention of the authorities being that the prices are unduly high. Electric lights are entirely thrown out, the rate being £29 5s. per year for each arc light. During the year 1903 the amount voted for lighting the city was approximately £661,270, while the sum provided in the budget of 1904 is £650,000.

An Enterprising American Firm.

During the past few months the International Telephone Manufacturing Company of Chicago have made an extensive enlargement of their plant, and have completed the equipment of special tools and machinery for manufacturing an improved generator-call, self-restoring drop switch-board system. The manner in which this new line has been appreciated, may be judged from the fact that, during a recent month, orders for seventeen complete equipments were received. A greatly increased demand is also being made for the long distance country party line and village exchange telephones made by the same firm, whose enterprise has been rewarded by an increase of business of over 500 per cent.

American Electrical Manufacturers.

From statistics recently published, that the total value of electrical and kindred products in the United States has substantially increased since 1902. The total for that year was £44,233,000, while the corresponding amount for last year reaches £46,950,000, an increase of about 5½ per cent. Owing to the general depression of trade, it was not expected by those competent to judge, that the total for 1903 would have been much, if any, more than that for the previous year. The increase from 1901 to 1902 was nearly 15 per cent., and notwithstanding the decrease in the rate of growth, satisfaction is generally expressed in the United States that the country not only held its own in 1903, but even surpassed the record of the year 1902. The figures to which we refer do not include plant furnished to central stations in connection with electric light installations, the value of which is estimated at £300,000.

A New Canadian Company.

The Stark Telephone, Light, and Power Company has recently been formed in Toronto with a capital of £1,000,000 to take over the Humber Light and Power Company, Ltd. This new corporation will develop the Stark patents, by which telegraph, telephone, light, and power services are furnished from one plant, and over the same circuit. Considerable additions will be made to the present works of the Humber Company, and one of the first contracts to be undertaken will be that of a telephone service at Toronto Junction.

SOME CONTRACTS OF THE MONTH.

Among other contracts awarded during the past month are the following :—

Tramways.

The Bradford Electric Tramways Co. has let the contract for the electrification of the Bradford Road tramways to Messrs. Dick, Kerr & Co., Ltd. Messrs. Dick, Kerr & Co., Ltd., have also secured a contract from the Preston Town Council to provide four single truck tram cars instead of four bogie cars at an extra cost of £228 per car.

Light.

The Blaydon Council have accepted the offer of the Priestman's Colliery Co. for supplying and erecting poles, wires, etc., for the electric lighting of Whinfield. The tender of Mr. Sinclair, Bo'ness, for the electric lighting of the town hall and library at £321 has been accepted by the Bo'ness Town Council. The Bristol Town Council have accepted the following tenders for plant at their new electricity works :—Messrs. McDowall, Steven & Co., Arc Lamp Standards, £2,850; Messrs. John Spencer, Ltd., Pipe-work at Avonbank Station, £1,270; and Messrs. Ferranti, Ltd., Power Switchboard, at Temple Bank, £715. The Dartford Urban District Council have accepted the tenders of Messrs. S. W. Gibson & Co., for wiring consumers' houses, and of Henley's Telegraphic Works Co., for the main extension and the supply of house service cable. The Hammersmith Borough Council have accepted the following tenders :—30 h.p. electric motor at £130, by the Fuller-Wenstrom Co.; Switchboard extensions at £242 10s., by Messrs. Ferranti, Ltd.; and alternating current arc lamps at £9 10s. each, by the Gilbert Arc Lamp Co. The Metropolitan Asylums Board have accepted the tenders of Messrs. Belliss & Morcom, for supplying a generating plant for the Grove Hospital at £1,136, and that of Messrs. Drake & Gorham for wiring the Fountain Hospital at £2,792. The Worthing Corporation have accepted the tender of the Hart Accumulator Co., to replace the B.P.T. and L. battery at the electricity works by 264 of the company's standard lighting type cells.

Power.

The Brighton Town Council have accepted the tender of Messrs. Babcock & Wilcox, at £28,140, for (1) Six water-tube boilers, two separately fixed superheaters, economisers, induced draught fans and motors, steel chimney stack, feed pumps, and exhaust heater, with foundations and necessary brickwork. (2) A system of steam, exhaust, feed, blow-off and suction pipes, together with their valves. (3) Cast-iron storage tanks, hot-well tank and water purifier. (4) 30 in. cast-iron circulating water pipes. The Brighton Council have also accepted the tender of the British Westinghouse Co. for substituting 75 K.W. exciters to three turbo-generators and switchboard in place of the 5 K.W. and switchboard, at £810 Mr. E. J. Saunders has secured a contract from the Croydon Corporation for the electricity station building extensions at £3,600. The tender of Mr. R. S. Blackburn for supplying service cable connections for consumers' premises, and for other works in connection therewith, has been accepted by the Hebden Bridge Committee of Electricity Works. The Radcliffe Urban District Council has accepted the following tenders :—Messrs. Etheridge & Clark, for the erection of engine house platforms and switchboard gallery at the electricity works, at £168 6s. 4d.; Messrs. J. G. Statter & Co., for the lighting and traction switchboards, at £1,345 12s 6d.; and Messrs. Robert Neill & Sons for the building work of the Lancashire Electric Power Co.'s first station at Radcliffe. For extensions at the Borough Electricity Works, Reigate, the following tenders have been accepted by the Town Council:—The General Electric Co., for the supply of alternator and steam engine; Messrs. Cowans, Ltd., for the switchboard and instruments; and the Wheeler Condenser and Engineering Co., for the condensing plant and cooling tower.

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

Parliament in 1904.

PROSPECTIVE MATTERS FOR LEGISLATION.

By the ASSOCIATE EDITOR.

THE month of February brings with it the opening of Parliament, and in view of the active political campaign over our fiscal policy, carried on since October of last year, all parties are looking forward to the new session with more than ordinary interest. In the present state of affairs it seems improbable that we shall have any public legislation this year to effect the much needed amendment of the laws relating to electricity; but in private legislation electricity will be well to the front, and the session of 1904 should produce some keen and interesting contests before committees, and may create precedents on important matters of principle. As usual, municipal corporations are prominent as promoters of electrical schemes, and probably the keenest fights will be over bills seeking to widen the already wide field of municipal trade. Tube railway schemes for London will be conspicuously absent from the long list of private bills to be considered this session. The reason of this, of course, is that the whole question of locomotion in London is at present being carefully considered by a Royal Commission, and until its labours are completed, no new underground railway schemes will be considered. A large mass of interesting evidence, much of it very valuable, was taken before Parliament rose, and during the recess the Commission has visited America, and has learned all the details of the procedure followed in New York, Boston, and other large cities, to secure the best possible facilities for public locomotion. The members have studied closely the constitution of such bodies as the Rapid Transit Commission of New York and the powers with which it is invested, and this information ought to be of great assistance to them when deciding whether Parliament ought to devolve its present powers upon some special tribunal, and what ought to be the character and powers of that tribunal.

THE LONDON TRAFFIC COMMISSION.

Remembering the haphazard manner in which Parliamentary committees are chosen, and considering the difficult and sometimes highly technical questions on which they are called to decide, it is easy to see that our present system is by no means an ideal one, and is, in fact, but ill-suited for the needs of to-day. We feel confident, therefore, that the commission will recommend a radical change; but undoubtedly it will be far from easy to select a special tribunal which will please all the powers that be. The County Council strongly objects to any body other than itself being allowed to have any voice whatever in tramway matters in London, and therefore demands that any tribunal that may be appointed shall have its powers limited to railway schemes; but obviously it would not be for the best interests of London to have the locomotion problem divided into two in this manner. Then the City Corporation would prefer that the whole question should be entrusted to a quite independent and unbiassed body, while the Borough Councils would oppose any scheme depriving them of their veto on proposals for tramways within their areas. All the conflicting interests will, no doubt, be carefully considered by the Commission; but the most important of all is the interest of the London public generally—an interest, be it noted, which is not necessarily the same as that of the County Council or Borough Councils, and to which the interests of these local authorities may even be antagonistic. The Commission, we believe, is fully alive to this fact, and we are therefore hopeful that the year 1904 may see the production of a thorough and scientific scheme for the solution of the traffic problem of London. The further evidence, now being heard, should be studied carefully by our readers.

BILLS FOR THE COMING SESSION.

The private bills which will this session come before Parliament include some power schemes, and still more tramway schemes. Some of these may call for particular notice when they reach the Committee stage, but at present we need only remark that an examination of the bills show, that local authorities are as active as ever this year in their attempts to cut out private enterprise. Not content with ousting companies from tramway enterprise within their areas, some seek powers to run omnibuses in addition. Others, again, are anxious, not only to sell and let for hire dynamos and all manner of electrical fittings, but also to manufacture such apparatus; and it is noteworthy that in some cases the old dodge is resorted to of putting the clauses for such powers in an omnibus bill, where they may escape the attention they would otherwise receive. This practice is one which should be condemned by Parliament, and in every case where it has been adopted the request for powers should be treated with suspicion, and refused. There was one Bill, deposited which deserved special attention, as it raised a supremely important question of principle, which Parliament must carefully consider. This was the bill in which the Glasgow Corporation sought powers to extend its tramway system several miles into country districts quite outside the municipal area. The history of this scheme is interesting, and may be told in a few words. The Clyde Valley Power Company is authorised to supply electric power in a large area around Glasgow, but not in Glasgow itself. A few months ago this company gave notice that it intended to apply for powers to introduce tramways in certain parts of its area, some of them coming near to the municipal boundary. The Corporation had pledged itself previously by formal resolution not to promote any further extensions until the lines within the city had been completely linked up, but as soon as the company appeared with this new scheme, the Tramways Committee met and prepared hurriedly a bill in which the Corporation asked powers for the same lines as those proposed by the company, and at a special meeting of the council, hastily summoned, this scheme was rushed through.

AN IMPORTANT ISSUE FOR PARLIAMENT.

The Corporation has since been compelled to withdraw this Bill, as it failed to obtain the necessary consents from the local authorities of the districts concerned; but the matter will probably be raised again, and we may therefore note the position of the Corporation. This body has the monopoly of electricity supply for lighting and power within its area and in some of the surrounding suburbs, and its tramway system also extends into suburbs outside the municipal area. But the districts included in the new scheme are not suburbs; they are largely country districts, in some cases very thinly populated, and part of the scheme actually involved running tramways for several miles through this bare country to an entirely independent burgh with 10,000 inhabitants. With this area Glasgow has no concern whatever, and these extensions would never have been thought of, but for the fact that the Corporation cannot bear to see any limit put to its ambition in tramway matters. A day will surely come when Parliament will have to consider this question; and if a precedent is created for wholesale extensions of municipal tramways far beyond the municipal boundaries, not only will the general outlook for private enterprise in tramway matters become black in the extreme, but the ratepayers of large towns may find themselves mulcted in heavy sums annually for the upkeep of unprofitable lines in distant out-of-the-way places,—lines not used by the ratepayers who are responsible for them, to satisfy the inordinate desires of selfish and irresponsible persons who do not hesitate to pledge the city's credit on any scheme which may bring them a little notoriety.

THE MARYLEBONE FIASCO.

In an editorial note in our last issue reference was made to the Electric Lighting Bill promoted by the Marylebone Borough Council to enable it to raise the sum fixed by the arbitrator as the price to be paid by the Council to the Metropolitan Electric Supply Company for that part of the company's system within the municipal area. It was there stated, in connection with the promotion of this Bill, that "the consent of the ratepayers will have to be obtained; but it is safe to presume the Bill will receive their sanction." Since then the ratepayers' meeting has been held, and the Bill did *not* receive their sanction. On the contrary, the proposal to promote this Bill was rejected by a very large majority, and this result is welcome. Ratepayers have for so long allowed their councils to go on from extravagance to extravagance without ever seeking to use the powers of control which they possess, that one almost despairs of ever seeing them thoroughly roused from slumber; but in Marylebone it is clear there is to be no more slumbering, and there may be a bad time ahead for those members of the present Council who have brought about the present deplorable muddle.

At a meeting of the Borough Council, held two days after the ratepayers' meeting, it was decided to take a poll of the ratepayers on the proposed Bill, and although that has not yet been done (at the time of writing), we are hopeful that the result will be to clearly and decisively confirm the vote given at the Queen's Hall meeting. Meanwhile, the Council is in anything but a happy position, and if it brings home to these men that great schemes, costing one or two millions, ought not to be undertaken without the most careful consideration of every eventuality, and teaches them that there is inevitable punishment for those who promote such schemes at the expense of the public pocket without any sense of responsibility, then something will have been gained. The farce is not yet ended, but the scene is frequently changing. Lately, when the company offered terms to the Council upon which they would release the Council from the capital payment required by the award, the reading of their letter was greeted with "loud laughter"; but had the members been more far-seeing, they would have realised that the laugh has from the first been with the company. Perhaps they know this now; and from the nature of some of the resolutions proposed at the Council meeting on January 21, it looks as if they did.

* *

ELECTRICITY IN BULK.

Prospective Demand for Capital.

If all the Power Bills now before Parliament are passed into law, there will be a big demand for capital from the public, as will be seen from the following list:

	Capital.
East London and Lower Thames	£2,000,000
Cheshire Electricity and Power Gas	1,000,000
Belfast and North-East Ireland ..	1,500,000
Lincolnshire and Yorkshire ..	996,000
Ulster Electric Power	900,000

The areas included in the third and fifth of these bills, however, overlap considerably; so that, if both are allowed to pass, it will probably entail a sacrifice by one or other, or both, of the companies of part of its area, and the capital may be affected correspondingly.

Lighting Orders Sought.

The applications for new powers are, however, more important, and some are significant. Parliament has not hitherto encouraged applications by power companies for ordinary electric lighting orders for districts within their areas, but several companies are making such applications this year, and—more important still—some are asking to take over provisional orders already granted to local authorities. This shows that these bodies are beginning to change their attitude to the power companies, to which they were at first entirely hostile, and that they are now recognising it to be more consistent with duty and common-sense to take the cheap supply of electricity, even if it be not "municipal," and exercise a wise economy, rather than to follow an unwise ambition.

Further Powers to Existing Companies.

Several of our authorised Power Distribution Companies are again before Parliament this year, to obtain further powers or to have restrictions by which they are at present bound removed. The principal change desired in the original Acts appears to be the removal of the restriction that generating stations shall not be constructed elsewhere than on sites specifically described in a schedule to each Act, and among the companies who are thus desirous to be "off with the old love and on with the new" are the Lancashire Electric Power Company, the Clyde Valley Electric Power Company, and the North-Western Electricity and Power-Gas Company.

Wood Green Electrical Affairs.

The Wood Green Urban District Council, after a heated debate in which personalities were plentiful, has rejected a motion "that enquiries be made as to the terms on which electricity can be supplied in bulk for the Council's electrical undertaking," and has resolved to go on with its application to borrow £43,000 for a generating station and electricity supply works. As the chairman rebuked the chief spokesman for municipalisation when that gentleman desired to refer to the "mentality or morality" of an opponent, we suppose it would be improper to enquire into the "mentality or morality" of this act. All we need say, therefore, is that we should have liked to see good reasons adduced, but such are not to be found in the report of the discussion.

* *

FINANCIAL NOTES.

The Tariff Commission. Electricity Represented.

Mr. Chamberlain's Tariff Commission has now fairly started on its inquiry, and no doubt it will do its best to formulate a satisfactory system to check the foreign invasion. Last month we expressed the hope that in any scheme the electrical industry would not be overlooked; but all fears on that ground have since been dissipated by the appointment of Mr. George Fleet, managing director of Dick, Kerr & Co., Ltd., to a seat on the Commission. In his hands the interests of the industry are safe, and his great personal ability and vast practical experience will make him an extremely useful member.

A Contrast.

As a contrast to Nottingham, we learn that the payment of interest and repayment of capital by the Stafford Town Council have, during the past ten years, entailed a charge on the rates of £5,616.

A Welcome Change.

We even find some local authorities—as, *e.g.*, the Urban District Council of Whickham (County of Durham), and the City Corporation of St. Alban's—themselves applying to Parliament this session for authority to transfer or lease to companies their powers under provisional orders granted to them. This is a welcome change.

Stoke-on-Trent Electric Lighting Loan.

The Local Government Board has sanctioned the borrowing of £30,640 by the Stoke-on-Trent Town Council for purposes of electric lighting and the provision of a refuse destructor, subject to the Council giving an undertaking not to manufacture mortar for sale, but only to sell surplus products not required for their own use. The Council has agreed to give the required undertaking.

Forward, Ireland!

Electric Lighting Prospects.

Ireland's greatest grievance will soon be that it is no longer a "distressful country." At a meeting of the Omagh Guardians last month, it was stated that some London gentlemen were prepared to invest a million pounds in Irish enterprise, principally in electric lighting. The Board approved of the object, and we wish it all success. May there be many millions more!

A Progressive Municipal Undertaking.

It is so common to have to chronicle financial loss in municipal electrical undertakings that we have all the greater pleasure in congratulating the Nottingham Corporation on the success of its electric lighting undertaking. Starting in 1895 with 114 consumers and an installation of 11,500 8-c.p. lamps, they have now 2,500 consumers using 232,413 8-c.p. lamps, and the price has been reduced from 5.97d. in 1895 to 2.19d. last year. In spite of these reductions the profits have greatly increased, and the Corporation is now about to borrow £100,000 for extensions.

Central London Traffic Returns.

The traffic returns on the Central London Railway for the latter half of 1903 are less by £6,782 than those for the corresponding period of 1902, while those for the City and South London Railway show a falling off, comparing the same periods, amounting to a little over £10,000. There is, however, nothing serious in this, when we remember that 1902 was abnormal, owing to the great influx of visitors to see the Coronation, and we have further to remember the peculiar weather conditions of 1903. On the South side of the river, of course, the County Council electric tramways may have had an effect on railway traffic, but it is not yet possible to estimate this effect accurately.

South African Branch of A.E.G.

We note the registration at Somerset House of the "A.E.G. Electrical Company of South Africa, Ltd." The names of the signatories and of the first directors are all German, and two of the directors have addresses in Berlin. We hope to see a large amount of electrical enterprise in South Africa, but we also hope that the orders will come to companies *really* British, and not only so in name.

London's New Tube.

London's newest "Tube," the Great Northern and City Railway, is now in running condition, and as, on its way from Finsbury Pavement in the City to Finsbury Park Station, it passes through (or rather, under) densely populated districts, we expect to see big traffic returns. In full running order there will be a 3-minute service provided by 11 trains, each having seating accommodation for 505 passengers, and completing the single journey of 3½ miles in 13½ minutes.

Liverpool Overhead Railway.

New Issue.

The Liverpool Overhead Railway is about to extend its lines to connect with the Lancashire and Yorkshire Railway at Seaforth Station, and for this purpose it has been decided to issue £60,000 additional share capital, in 6,000 preference shares of £10 each, bearing interest at 5 per cent. The linking-up of the electric with a main-line railway ought to lead to a considerable increase of traffic, which will fully justify the progressive policy of the company.

GENERAL.

Northern Lights.

The Aberdeen Town Council has received the consent of the Secretary for Scotland to borrow a further sum of £65,000 for purposes of electric lighting under the Provisional Order of 1890. This raises the total sum authorised to be borrowed for that purpose to £250,000.

Municipal Compensation for Accidents.

The Sheffield Corporation hopes, after March 25th, to be in a position to smash, electrocute, or damage the ratepayers who are passengers on the municipal tramcars, at no greater cost than £25 in each case. It has decided to print on all tickets issued after that date a notice limiting its liability to that sum in all cases of accident to passengers for which it is liable. Sheffield is not the first Corporation to adopt this course, and it is somewhat curious, and not without significance, that the municipalities should be more anxious than private companies to limit their liability. This is evidently to be a concomitant of cheap fares, as it is always stated in the notice to passengers that this condition is made in consideration of the fact that "passengers are being carried at less than the maximum authorised charges." Another victory for cheap municipal fares! But will the ratepayers agree to this bye-law? And to what extent may this principle be carried? If the fares are further reduced, will a further reduction of liability be possible? We confess the excuse does not seem to us a very strong one, and we should like to see the question tested. It looks like putting a premium on negligence.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A., 72 Fleet Street, E.C.

Alternating Electric Current Systems and Switches.

Christian Reider, Elberfeld, Germany. No. 28,078. Dated 19th Dec., 1902.

This invention has for its object to economise in the cost of installation, when, for example, a plant is in question working 1, 2 or 3 arc lamps together; moreover, to prevent waste of energy and, finally, to facilitate the adaptation of the switch arrangements to the requirements as to light and energy respectively.

Claims.—(1) An alternating current electric system operating one, two, or three energy consuming objects, characterised by the feature that, for the purpose of working all three energy consuming objects, they are placed in series direct in the line together with the resistances or rheostats, if such be required, and without making use of the converter, whilst for working 2 or 1 such energy consuming objects, the required potential is obtained by means of a bipolar and tripolar switch, which are combined with a converter provided with a subdivided coil, the divisions of the latter being in proportion of 1/3 to 2/3 of the entire energy.

(2) An alternating current electric system operating one, two, or three energy consuming objects, characterised by the feature that for the purpose of working all three energy consuming objects, they are placed in series direct in the line, together with the resistances or rheostats, if such be required, and without making use of the converter, whilst for working 2 or 1 such energy consuming objects, the required potential is obtained by means of a combination switch replacing the two separate switches, and being combined with a converter provided with a subdivided coil, the divisions of which are in the proportion of 1/3 to 2/3 of the entire energy.

Steam Turbines.

Johann Stumpf, Charlottenburg, Germany. No. 135. Dated 2nd Jan., 1903.

This invention relates to steam turbines, and more especially to such as are provided with return buckets, by means of which the steam leaving the turbine wheel flows back into the buckets.

Claims.—(1) A steam turbine, in which the steam is once or several times conducted back by means of fixed return buckets into the buckets of the turbine wheel, said turbine being so constructed, that the angle of inclination at which the steam enters the return buckets is different to the angle of inclination at which the steam leaves the same.

(2) A steam turbine, in which the angle of inclination of the admission nozzle is different to the angle of inclination of that side of the return buckets, which conveys the steam back to the turbine wheel.

(3) A steam turbine, in which the cross section of the return buckets increases according to the dimunition of the streaming velocity of the steam.

(4) A steam turbine having several guide-ribs or partitions arranged in the return buckets.

(5) A steam turbiue in which the inside of the return buckets is provided with a wall so that closed guide channels for the steam are formed.

(6) A steam turbine described having a double bucket-wheel with double return buckets.

Electrical Measuring Instruments.

Chamberlain & Hookham, Ltd., Birmingham, and James Francis Watts. No. 143. Dated 3rd Jan., 1903.

This invention has for its object the provision of a simple means of measuring the maximum demand made by a customer upon an electrical supply system. It consists in employing a compensated thermal bar system, one member of which is heated directly or indirectly, by, or from, the measuring or indicating current, and produces the deflection which serves to indicate or record amperes, or volts, or the maximum demand on a supply circuit.

Claims.—(1) An electrical instrument having a compensated thermal bar system one member of which is electrically heated, in any suitable manner, and serves, by its consequent deflection, to indicate or record amperes, or volts, or the maximum demand, on a supply circuit.

(3) In an electrical instrument as above claimed, the combination of a thermal strip, a winding surrounding the strip, and adapted to heat it when current passes, together with non-return mechanism for recording the maximum demand as represented by the bending of the thermal strip.

(3) In an electrical instrument (see Claim 1), means for compensating for variations of the external temperature consisting of two thermal bars, the component metals of which are oppositely disposed, so that their actions on the indicator counterbalance.

(4) The compensated electrical instrument hereinbefore described with reference to the drawings.

Electric Fuse Pillar Boxes.

Callendar's Cable and Construction Company, Limited, and John Charles Augustus Ward, London. No. 1,054. Dated 15th Jan., 1903.

The door of the box is made in two parts, the upper part preferably turning about vertical hinges and the lower part about horizontal hinges at its bottom, so that when turned down it forms a platform on which the workman can stand, and this lower part is lined with a mat of rubber, or like material, so that a workman standing upon it is insulated. The pillar is ventilated both at the top and bottom. Curved guards are placed inside the box, to turn aside and prevent an inserted wire reaching the fuses or exposed conductors.

Claims.—(1) A pillar box having a door hinged at its bottom and insulated on the inside.

(2) The combination with ventilating openings, of guards.

(3) Pillar boxes substantially as described and illustrated in the drawings.

Means for Promoting Combustion and for Smoke Consuming or Preventing Purposes for use in Connection with Steam Generator Furnaces.

Oswyn St. Leger Davis and John Booth, both of Castleton. No. 2,911. Dated 7th Feb., 1903.

The invention has reference to improved means or arrangements for consuming or preventing smoke, and for promoting combustion of fuel in steam generator furnaces.

Claims.—(1) A combustion promoting or smoke burning arrangement for steam generators, consisting of a pipe (or pipes) having inlet ends for the front of the generator, each leg, or the legs of the pipe or pipes reaching from the bridge, said pipe (or pipes) being disposed in the combustion chamber and below the crown of the flue, said pipes having steam or air nozzles at their inlet ends and being formed or provided with outlets or orifices transversely and about the bridge.

(2) A combustion promoting or smoke burning arrangement, consisting of a pipe (or pipes) arranged in the combustion chamber and having a connecting pipe with air outlets to the rear of the bridge, the longitudinal lengths of pipe being provided with air outlets or orifices pointing forwards and downwards so as to to cross or intersect said lengths, being supported about the bridge on hollow boxes of refractory material into which air nozzles preferably project.

(3) The general construction and combination of parts forming the combustion promoting or smoke burning arrangements.

Electric Locomotives.

James Swinburne, Victoria Street, London. No. 26,717. Dated 4th Dec., 1902.

This invention has reference to a locomotive which is worked by a constant speed motor, such as an ordinary single phase alternating current motor.

Claims.—(1) An electromotive in which one element of the electromotor drives the driving wheel or wheels directly or positively, and the other element drives through variable speed gear, substantially as described.

(2) An electromotive in which one element of the electromotor drives the wheels positively, and the other element drives through liquid pumps substantially as described.

(3) In a variable speed gear for electromotives the double eccentric substantially as described.

Automatic Shunting Switch for Protecting the Shunt Coils and Carbon Holders of Arc Lamps.

August Eckstein, and Arthur Ernest Angold, both of Salford, Manchester. No. 23,694. Dated 30th Oct., 1902.

The invention relates to an improved arrangement of a shunting switch, whereby the fine wire coils, and the carbon holders, of arc lamps (particularly those controlled by shunt coils only), are protected from injurious excess currents by automatically preventing the maintenance of any abnormal voltage across the terminals of the lamps; and is more especially applicable in cases where lamps are run in series on circuits whose total voltage exceeds in amount upwards of three times that across the terminals of one lamp.

Claim.—In an apparatus for protecting the shunt coils and carbon holders of arc lamps, the use of an automatic switch consisting of an iron core A, wound with magnetically opposed windings —of coarse wire D, in series with the lamp, and fine wire B, in shunt across the leads C, C^1,—with the armature F, or equivalent electro-magnetic device, and the contacts G, G^1, or the like, in combination with the substitutional resistance H, whereby abnormal rise of voltage across the terminals of an arc lamp is prevented, substantially in the manner as described and illustrated.

Do not fail to become an Annual Subscriber to *The Electrical Magazine* without delay. We offer advantages which are not procurable with any other technical monthly, and these should be embraced while yet available. Write us at once.

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers will be given.

* * *

The Practical Engineer Electrical Pocket Book and Diary, 1904.

5th Edition. Technical Publishing Co., Ltd., Manchester. Price 1/-

This pocket book still maintains its popularity and, as usual, enlargements and additions have been made. Among the latter are the standards of electrical conductors of the Cable Makers' Association, and some additional facts relating to conduit wiring. The book contains a number of useful tables.

The Practical Engineer Pocket Book.

16th Edition. Technical Publishing Co., Ltd., Manchester. Price 1/-

The contents of this book have been thoroughly revised and a number of interesting alterations and additions made, including descriptions of the Stirling water tube boiler and the Daimler motor. Two pages only are devoted to steam turbines, a fact probably accounted for by the comparative reticence of manufacturers in supplying details of such machines. The gas engine section contains some useful matter, but practically no detailed reference is made to the latest high speed types, for coupling directly to dynamos.

Depreciation, Reserves, and Reserve Funds.

By L. R. Dicksee. Gee & Co., 34 Moorgate Street, E.C. Price 3s. 6d.

This work forms Vol. XXVI. of "The Accountants' Library" series, and deals in an interesting fashion with a very important subject. Opinions differ greatly as to the proper basis upon which to charge depreciation allowances, and if we are to judge by the actual allowances made in particular cases, especially by local authorities in their trading departments, it is clear that there is great need for a scientific exposition of the business principles involved in this subject. Mr. Dicksee has succeeded in treating the matter very concisely, yet very clearly, and we hope that his remarks on depreciation of freehold and leasehold lands, of plant and machinery and tools, and of such elusive matters as patents, copyrights and goodwill, will be widely read. There are also chapters on Reserves, Reserve Funds, and Sinking Funds, and a very instructive chapter on "Local Authorities and Depreciation," which shows the absurdity of the supposed relationship between Sinking Funds and Depreciation, upon which so many local authorities act. We recommend the book to business managers

Notice sur le Chemin de Fer Électrique du Faget à Chamonix et à la Frontière Suisse.

(The Electric Railway from Faget to Chamonix and the Swiss Frontier.)

By M. Geoffroy. E. Bernard, Paris. Price 2s. 6d.

This is a reprint from *The Annales des Ponts et Chaussés*, and gives a very complete description, illustrated by numerous plans and drawings, of this interesting line.

Mechanical World Pocket Diary and Year Book.

17th Edition. Emmott & Co., Ltd., Manchester. Price 6d.

This pocket book contains interesting matter upon power transmission, the care of dynamos and motors and electric cranes, which will make it useful among electricians.

The Story of the Atlantic Cable.

C. Bright, F.R.S.E. George Newnes, Ltd., Strand, London, W.C. Price 1/-

This little book, coming as it does directly upon the jubilee of submarine telegraphy, will be found an interesting history of the laying of the Atlantic cable. It may be read alike by telegraph engineers and the general public.

Traite Pratique de Telecommunication Electrique.

(Télégraphie—Téléphonie).

Par Edouard Estaunie, ancien élève de l'Ecole Polytechnique, Ingenieur en Chef des Télégraphes. 1904. Paris: Librairie Vve. Ch. Dunod, Editeur, 49, Quai des Grands-Augustins. 20 fr.

In this volume of 670 pages an attempt is made to deal with the subject of electrical communication to a distance as one homogeneous whole, treating telegraphy and telephony not as distinct subjects, but as fundamentally the same in principle, though the applications of the principles are somewhat different in the two cases. There is an advantage in this method of treatment in that it is more essential for the student to realise the unity between the two applications of electricity to signalling than to emphasize the differences, which are fairly obvious. The author has evidently devoted much care and thought to the preparation of the volume. His explanations of theoretical principles in the first four chapters are admirably clear, and the arrangement and gradual development of the subject, showing how these principles are applied in practice, are excellent. In chapter v. there is a very full discussion of the different types of telegraphic apparatus in common use, and in chapter vi. the factors affecting the efficiency of the apparatus are carefully analysed and their effects explained. Part II. is devoted to the organisation of telegraph and telephone offices and exchanges, and gives a very practical discussion of the separate details, the use of which is involved in such installations. The final chapter treats of the equipment for testing purposes. The volume is very instructive and will repay careful study of its contents.

Municipal Trade:

The Advantages and Disadvantages Resulting from the Substitution of Representative Bodies for Private Proprietors in the Management of Industrial Undertakings.

By Major LEONARD DARWIN. John Murray, London. 12s. net.

The subject of municipal trading has been much discussed of late in the press and in magazine articles, and has also formed the subject of inquiry by a Parliamentary Committee. These discussions are, as a general rule, of a practical character, and the arguments are based upon actual facts relating to particular enterprises conducted by municipalities in different parts of the country. The present volume, however, is somewhat different in tone. Major Darwin has studied the subject from what may be called the academic point of view, and seeks to weigh impartially against each other the advantages to be obtained by municipalities undertaking the management of large industrial undertakings, and the corresponding disadvantages. At the outset he points out that the development of municipal trade is the outcome of the same forces which have given rise to socialism, and he discusses the socialistic argument that wages and conditions of labour are improved under municipalisation, showing that, if this be true, the result is unjustifiable, as it is obtained by increased cost of production. After considering the characteristic features of monopolistic trades, the author concludes that in such trades, prices must be regulated by the State, and that this can be done in one of two ways—municipalisation, or private management under State control; which of these is to be chosen, is the subject to be discussed. The advantages of municipal trade are first considered, and the author is even generous to the municipalists. He then turns to the disadvantages, which occupy the rest of the volume; at least, the different phases of the subject are considered, and in almost every case the author is led to give his decision against municipal trading. Municipal house-building is taken as an example for illustration of the arguments *pro et con*, while three chapters are devoted to various aspects of the financial side of the question. To our mind these three chapters are the most interesting, although on some points the author is not quite reliable, in that he has failed to consider the present absence of depreciation allowances in his estimate of possible profits in the future.

There is some "overlapping" in the volume, and again, minor matters have been treated at greater length than they deserve, while some more important points have been overlooked or barely mentioned; but, on the whole the volume provides excellent reading, and the author deserves great credit for his painstaking effort to investigate thoroughly a most important subject. Municipal trading hardly allows of quite satisfactory discussion from a theoretical point of view, but there *is* a theoretical side; there are economic and moral principles to be considered, and while the actual phenomena of municipal trading may help to show the working of these principles, there is room for the discussion of the principles themselves. Major Darwin's volume is, therefore, a welcome addition to the literature on the subject.

Theorie und Berechnung Elektrischer Leitungen.

(Theory and Calculation of Electric Networks.)

By H. GALLUSSER and M. HAUSMANN. T. Springer, Berlin, 1904. Price 5 marks.

This is an interesting work on an important subject, hitherto comparatively neglected by text-book writers. It is thoroughly practical, the authors being engineers in the employment of Messrs. Brown, Boveri & Co., and of the Allgemeine Elektricitäts Gesellschaft, respectively. It should be of great assistance both to the student and the engineer who has to deal with the construction or maintenance of cable networks. The volume contains eleven chapters and an excellent index, the subjects being: Monophase Networks; The Three-wire System; Polyphase Systems; Feeders; Conductor Calculation, from the point of view of Heating, of Voltage-drop, and of Economy, respectively—a special chapter being devoted to Booster Feeders; The Determination of the most Economical Voltage, and of the most Economical System, respectively; Regulation. The method employed is a development of the one proposed by Frick in 1894, which greatly simplifies the calculations. The work is one which we should greatly like to see in the form of an English translation.

Conduction of Electricity through Gases.

J. J. THOMSON, 1903. Cambridge University Press. Price 16s.

This is a treatise on the ionisation theory of gaseous conduction by its author. It consists in the main of a connected account of his own experimental researches and those of other workers bearing on the subject, so thoroughly brought up to date as to include, in the form of supplementary notes, the results of work published during the earlier months of last year. A very noteworthy feature is the value and extent of contributions from old pupils of Prof. Thomson. The whole line of argument, including the necessary mathematical theory, is very clearly and ably set forth; and, which will be a boon to many readers, the analysis, though fully adequate, is never of an advanced or difficult character. The two opening chapters develop the first portion of the foundations of the theory, *viz.*, that the charge of a gaseous ion is a constant quantity under all circumstances, and equal to that of the hydrogen ion in electrolysis. Then follow two chapters dealing mathematically with the general theory of conduction in ionised gases and the effects of a magnetic field on the motions of ions.

Chapter V. deals with the very important subject of the determination of the ratio of charge to mass in the particles occurring in kathode rays and radium emanations, and those emitted in gas at very low pressure, by incandescent carbon filaments and metals exposed to ultra-violet light. In Chapter VI. the values so obtained for the ratio e/m, of the charge to the mass of an ion, are used, in combination with the values of e obtained for ordinary gases, on the assumption that e is the same throughout, and this leads to the determination, in Chapter VII., of the charge of a negative ion

This identification of the values of e, occurring under widely differing conditions, although it appears highly probable that it is correct, nevertheless, undoubtedly, forms the weakest link in the chain of argument. Chapter VII. deals with some physical properties of gaseous ions, including C. J. R. Wilson's beautiful condensation method of determining e in the case of ordinary ionised gases, the results of which confirm the results obtained by independent methods in the earlier chapters. Then follow four chapters on ionisation, by incandescent solids, in gases from flames, by light, and by Röntgen rays. Chapter XII., on Becquerel rays, is the longest in the book, and gives, with the supplementary notes, an admirable summary of the most important researches on radio-activity almost up to the date of publication.

The remaining chapters deal with :—Spark Discharge ; The Electric Arc ; Discharge at Low Pressures ; Theory of Vacuum Tube Discharge ; Kathode and Röntgen Rays ; and the Properties of Moving Electrified Bodies.

Electric Traction.

By J. H. Rider. Whittaker & Co., Paternoster Square, London. Price 10s. 6d.

In this little volume, which has been added by Messrs. Whittaker to their well-known "Specialist" series, the author deals with the application of electricity as a motive power, more especially with reference to electric tramways. The position of Mr. Rider as chief electrical engineer to the London County Council Tramways gives special interest to the views expressed in the book. The treatment of the subject in the fourteen chapters into which the work is divided is by no means exhaustive, but rather aims at giving a general survey of the whole question regarded from a purely practical point of view. The introductory chapter, after briefly dealing with the principles of dynamos and motors, discusses the calculation of the tractive effort required to start a car from rest, and the horse-power required to maintain a constant speed on any given gradient. In comparing the running costs on various lines, the author suggests as a basis of calculation the adoption of the "passenger capacity mile" in preference to the usual "car mile." He points out that after all the direct object of a tramway is to convey passengers, whilst the cars are only employed as a means to this end. In chapters ii. and iii., generating plant and switch gear are briefly discussed, then follows a chapter on distribution, containing a simple graphical method of arriving at the most economical size of conductor. This chapter, especially that portion dealing with three phase distribution, might with advantage have been considerably extended. Motors and controllers are the subjects of the next two chapters, interesting diagrams being given to illustrate the advantages of a series parallel control for motors. Rolling stock and permanent way occupy chapters vii. and viii. In the four succeeding chapters descriptions are given of the various systems of traction, *viz.*, overhead, conduit, surface contact, and accumulator, the comparative advantages and disadvantages attached to each system being dwelt on. The last section—a small one—is devoted to electric railways, in which the author expresses the opinion that from the point of view of the rapid acceleration obtainable by electric traction, the conversion of suburban lines from steam to electric traction is only a matter of time. The book is clearly written and well illustrated. Some information, giving comparisons of the actual cost of running, costs of maintenance and depreciation of plant on the various systems, would have been a valuable addition to the work. Also the application of electric traction for haulage of goods traffic on canals, a possible important application in the near future, and some reference to the high speed electric traction experiments being made on the Continent might be included when a new edition of the book is required.

* * *

BOOKS RECEIVED.

Hazell's Annual for 1904. Hazell, Watson, & Viney, 52 Long Acre, W.C. 3s. 6d.

The Story of Rapid Transit. B. Willson. George Newnes, Ltd., Southampton Street, Strand, W.C. 1s.

The Story of Electricity. J. Munro. George Newnes, Ltd. 1s.

The Colliery Manager's Pocket Book, 1904. The Colliery Guardian Co., Ltd., Furnival St., E.C. 2s.

The Grant and Validity of British Patents for Invention. J. Roberts. John Murray, Abermarle St., W. 25s.

Modern Electric Practice. Vol. I. Gresham Publishing Co., 34, Southampton St., Strand, W.C. 9s. (In our last number this was incorrectly stated as issuing from Blackie & Son, Glasgow).

The Penrose Pictorial Annual. The Process Year Book, 1903-4. A. W. Penrose & Co., 109 Farringdon Road, E.C.

Railways. E. R. McDermott. Methuen & Co., Essex St., W.C. 2s. 6d.

Protection and Industry. Various writers. Methuen & Co. 1s. 6d.

Elektrische Apparate. G. J. Erlacher. Gebrüder Jänecke, Hanover. 8 marks.

Geometry for Technical Students. E. H. Sprague. Crosby, Lockwood & Son, Ludgate Hill. 1s.

Gas and Oil Engine Management. M. P. Bale. Crosby, Lockwood & Son.

Telephone Lines. W. C. Owen. Whitaker & Co., Paternoster Square. 5s.

Electricitie dans les Mines en Europe. E. Guarini. Ramlot Frères et Sœurs, Brussels. 5 francs.

The Factory Manager and Accountant. H. L. Arnold. "The Engineering Magazine." London.

Specielle Elektrochemie. (Special Electro Chemistry). H. Daneel. W. Knapp, Halle, 1903. 3 marks.

Die Elektrolyse des Wassers. (The Electrolysis of Water). V. Engelhardt. W. Knapp, Halle. 5 marks.

Electrical Engineering. E. Rosenberg. Harper & Bros., Albemarle St., W. 6s.

"Technics," February. A Magazine for Technical Students. George Newnes, Ltd. 9d.

"The World's Work," February. William Heinemann, London. 1s.

A comprehensive and concise record of the latest books on technical, electrical and allied subjects will be presented in this section every month. A special feature will be made of posting our readers on all modern recognized text books.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whole will form an index guide of considerable importance and value.

❦

Power.

Articles.

Exeter Electricity Works.	*Electn.* 11/12/03.
* Montreal, the Greatest Centre of Transmitted Power (Serial II. Concluded 26/12/03). A. D. Adams.	*Elec. Wld. & Eng.* 12/12/03.
Motor Driven Machinery. F. B. Kleinhaus.	*Elec. Wld. & Eng.* 12/12/03.
The New York Edison Co, Electricity Works. E. Cronwall and A. Westerberg.	*Tek. Tids.* 12/12/03.
Tension Formation in two-phase Transmission Plants.	*Tek. Tids.* 12/12/03.
Electrical Constants of Porcelain Insulators at High Tension. R. M. Friese.	*Elek. Zeit.* 12/12/03.
Development of Cologn Electricity Works. Overmann.	*Elek. Anzr.* 17/12/03.
Recent Extensions, Bradford Corporation Electrical Undertakings (Concluded 25/12/03).	*Elec. Rev.* 18/12/03.
German Gas Engine Power Stations. F. C. Perkins.	*Elec. Wld. & Eng.* 19/12/03.
Electrically Operated Locomotive Crane.	*Elek. Anzr.* 25/12/03.
The Edison Portland Cement Co.	*Elec. Rev. N.Y.* 26/12/03.
Electrical Equipment of the Edison Portland Cement Company.	*Elec. Wld. & Eng.* 26/12/03.
Christchurch Electricity Works.	*Elec. Rev.* 1/1/04.
• The Electrical Equipment of the U.S.A. Government Printing Office (Serial, concluded 9/1/04)	*Elec. Wld. & Eng.* 2/1/04.
Electric Plant of the Lackawana Steel Co.	*Elec. Wld. & Eng.* 2/1/04.
• Protection of Electrical Apparatus from Lighting and other Destructive High Potentials. H. R. Sargent.	*Elec. Wld. & Eng.* 2/1/04.
A Combined Steam and Water Power Station.	*Elec. Wld. & Eng.* 2/1/04.
Water Power Electrical Generating Plant at Riva, Tyrol. F. Koster.	*Elec. Wld. & Eng.* 2/1/04.
Two Phase Plant at Christiania. F. C. Perkins.	*Electy. N.Y.* 4/1/04.
Electric Power in a Lothian Oil Mine. N. D. Cameron.	*Elec. Rev.* 8/1/04.
The Vienna Austria Municipal Power Plant. F. Koster.	*Elec. Rev. N.Y.* 9/1/04.
The Progress of Electrical Development in 1903. C. L. Durand.	*Elec. Rev. N.Y.* 9/1/04.
The Electric Equipment of a Food Conservatory. W. C. Marlow.	*Elec. Rev. N.Y.* 9/1/04.
Swindon Corporation Electricity Works.	*Elec. Rev.* 15/1/04.
Guard Wires for Transmission Lines. A. D. Adams.	*Elec. Rev. N.Y.* 16/1/04.
St. Beron Electrometallurgical Society Power House of the Chailles Valley. C. Domar.	*L'Eclair Elec.* 16/1/04.
Electric Capstans.	*L'Eclair Elec.* 16/1/04.
Statistics of Norwegian Electricity Works.	*Elektro. Tids.* 18/1/04.
Cascade Connections in Motors with Rolling Mills. E. Danielson.	*Elek. Zeit.* 21/1/04.
The Congress of the Houille Blanche. M. Bloch.	*Elec. Rev.* 22/1/04.
Chevre Hydraulic Station. B. F. Hirschauer.	*Elec. Rev. N.Y.* 23/1/04.
New Electric Plants and Agricultural Concerns.	*Elek. Anzr* 28/1/04.
Power House of Gavet-Clavaux.	*L'Eclair. Elec.* 30/1/04.
Manchester Corporation Power Station. I. W. Chubb.	*Power. Jan.* '04.
Blast Furnace Gas as a Source of Power.	*Power. Jan.* '04.

Papers before Societies.

° Safeguards and Regulations in the Operatation of Overhead Distributing Systems. W. C. L. Eglin.	*Inst.E.E. N.Y.* 18/12/03.
Overhead High Tension Distributing System in Surburban Districts. G. H. Lukes.	*Inst.E.E. N.Y.* 18/12/03.
Gas Plant for Central Power Stations. J. R. Bibbins.	*Inst.E.E. N.Y.* /12/03.
Coal Cutting by Electricity. A. J. Tonge.	*Manch. Geol. and Mining Soc.* 12/1/04.
Three-phrase Working with special reference to the Dublin System. W. Brew.	*Inst.E.E. Dublin.* 14/1/04.
Energy Distribution to Sub-stations. C. A. Smith.	*Inst.E.E. Birm* 27/1/04.
Power Transmission at High Potentials. J. W. Harris.	*Brit. Westinghouse Eng. Soc.* 28/1/04.
Electrical Transmission of Power in Works and Factories. G. H. Bowden.	*Bradford Textile Assoc.*

Traction and Transport.

Articles.

Single Phase Alternating Current, Motor without Collector, Starting under Load. Dr. M. Corsepius.	*Elek. Zeit.* 10/12/03.

Burton Tramways.	*Elec. Rev.* 11/12/03.
Durban Electric Tramways.	*Elec. Rev.* 11/12/03.
• Interurban Electric Traction Systems. Alternating *versus* Direct Current. P. M. Lincoln.	*Elec. Wld. & Eng.* 12/12/03.
• Monophase Traction. Regulation of Speed and Recovering of Work. M. Latour.	*Elek. Zeit.* 17/12/03.
Tyer Railway Signalling Apparatus. A. Fernandez.	*La Ener. Elec.* 25/12/03.
La Mure Railway, 2,400 volts Direct Current. S. Herzog.	*Elek. Anzr.* 25/12/03.
The Paris Metropolitan Railway. (Contd. 10/1/04). E. de Loyselles.	*La Revue Tech.* • 25/12/03.
• Application of Single Phase Current for Traction and Tramway Services. B. G. Lamme.	*Elec Wld. & Eng.* 26/12/03.
Mountain Climbing Railways G. E. Walsh.	*Elec. Rev. N.Y.* 26/12/03.
Electric Traction on Austrain Main Lines.	*L'Ind. Elec.* 26 12 03.
Electric Canal Hauling on Teltow Canal.	*Elek. Zeit.* 31/12/03.
Marienfeld-Zossen High Speed Trials.	*Elek. Zeit.* 31/12/03.
Safety Device for Trolley Tramway Lines. S. G. Gai.	*L'Elettr. Dec.* /03
Some Notes on Tower Wagons. L. E. Harvey.	*Elec. Rev.* 1/1/04.
The Results of the Marienfeld Zossen High Speed Trials (Concluded 9/1/04). A. Gradenwitz.	*L'Electn.* 2/1/04.
° The Arnold Electro-Pneumatic Railway system on the Lansing, St. Johns and St. Louis Railway. B. J. Arnold.	*Elec. Wld. & Eng.* 2/1/04.
Novel Electric Railway Traction System. E. Lenggenhager.	*Elek. Anzr.* 7/1/04.
Monophase Alternating Current Commutator Motors, Origin, Working, Regulation and Critical Suryey. M. Osmos.	*Elek. Zeit.* 7/1/04. *(concld.* 14/1/04*)*.
Insulation Measurements on Tramway Trolley Wires. H. A. Mörk.	*Elek. Zeit.* 7/1/04.
Barking and Beckton Light Railway.	*Lt. Rwy. & Tr. Jrnl.* 8/1/04.
Car Wheels and Tyres. R. J. Simpson.	*Lt. Rwy. & Tr. Jrnl.* 8/1/04.
Electric Traction in 1903. L. Bell.	*Elec. Rev. N.Y.* 9/1/04.
New York Rapid Transit Subway. S. W. Aske.	*Elec. Rev. N.Y.* 9/1/04.
Consideration Electric Traction on Main Line Railways. R. Bonnin.	*La Rev. Tech.* 10/1/04.
Comparison between Electric and Steam Locomotive Traction	*L'Elettr.* 15/1/04.
Electric Traction on the lines of St. George's de Commiers to La Mure.	*L'Electn.* 16/1/04.
L.C.C. Tramways.	*Electn.* 16/1/04.
Electric Railway Safeguard and Signalling Device. A. Hecker.	*Elek. Anzr.* 17/1/04.
Electric Traction Plant without Rotating Motors. W. Leinveber.	*Helios.* 20/1/04.
The St. Louis Exhibition Electric Tramway. F. Welz.	*L'Ind. Elec.* 25 1/04.
Measuring Car of the Great Berlin Tramway Co. (Grosse Berliner Strassenbahn Ges.) E. Björkegren.	*Elek. Zeit.* 28/1/04.
° Electric Traction on the North-Eastern Railway.	*Tram. and Rwy. Wld.* Jan. 04.
The Munzie, Hartford & Fort Wayne Railway.	*Street Railway Rev.* Jan. /04.
A Suspended Railway Project for Hamburg.	*Street Railway Rev.* Jan. 04.
Materials and Supplies Accounting. W. S. Dimmock.	*Street Railway Rev.* Jan. 04.

Papers.

The Evolution of the Electric Railway Motor. S. T. Dodd.	*Elec. Soc. N.Y.* 16/12/03.
• City & South London Railway. Working Results, etc. P. V. Mahon (Adj. Disc 15/1/04).	*Inst E.E.* 17/12/03.
Electric Operation of Railways. Dahlander.	*Norwegian Assoc. Eng. & Arch.* 18/12/03.
Electric Signalling on Railways. W. Weissenbruch.	*Soc. Belge d'Electrs* 19 12 03.
Electric Equipment of Light Railways. J. Malcolm Bell, B.Sc.	*Inst.C.E. Glasgow Assoc. of Students.* 31/12/03.
° The Electrical Reconstruction of the South London Tramways on the Conduit System. A. Millar.	*Inst. C.E.* 19/1/04.
The Rating of Tramway and Railway Undertakings. W. G. Bond.	*Tramway & Lgt. Rwy. Assoc.* 28 1 04.
The Edison Accumulator for Automobiles (Adj. Disc.) W. Hibbert.	*Inst. E.E.* 28 1 04.

Lighting & Heating.

Articles.

Fireproof Wire with Homogeneous Insulation. W. H. Easton.	*Elec. Wld. & Eng.* 5/12/03.
The Conductivity of Mercury Vapour.	*Elec. Wld. & Eng.* 19/12/03.
Electric Welding.	*Elek. Anzr.* 20/12/03.
On the Distribution of Light from Incandescent Lamps. L. W. Wild.	*Elec. Rev.* 1/1/04.
The Gas that Failed. A. D. Adams.	*Elec. Wld. & Eng.* 2/1/04.
Electricity in Illumination and its Relation to the Fire Hazard.	*Elec. Rev. N.Y.* 2/1/04.
The Progress of Electricity during 1903. J. Trowbridge.	*Elec. Rev. N.Y.* 9/1/04.
Some Notes on Electric Lighting. C. L. Edgar.	*Elec. Rev. N.Y.* 9/1/04.
Municipal Public Lighting System in Milan. L. D. Andries.	*L'Elettr.* 15/1/04.
Mercury Arcs. De Valbreuze.	*L'Eclair Elec.* 16/1/04.
Electric Lighting for Separate Buildings. O. Arendt.	*Helios.* 20/1/04.
Triplex Arc Lamps. F. Hoppe.	*Elek. Anzr.* 24/1/04.
Effect Arc Lamps.	*Die Elektr.* 29/1/04.
Researches on the Three-Phase Voltaic Arc. P. L. Mercanton.	*L'Eclair. Elec.* 30/1 04.
Problem of Flicker Photometry. H. Kruss.	*Physik. Zeit.* 1/2 04.

Papers.

Electric Railway Lighting. C. A. Thorne.	*Norwegian Polytech. Assoc.* 15 12 03.
The Necessity for the Standardization of Wiring Rules.	*Lond. Elec. Contr. Assoc.* 5/1/04.
Researches on the Alternating Arc. M. Laporte.	*Soc. Inter. des Electrs.* 6/1/04.
Central Station Heating. W. H. Schott.	*North-West Elec. Assoc. U.S.A.* 20 1 04.
On the Osmium Lamp. Prof. L. Lombardi.	*Elek. Zeit.* 21/1/04.

Telegraphy and Telephony.

Articles.

Novel System for Connecting Apparatus on Telegraph and Telephone Lines A. Banti.	*L'Elettr. Jan* 03
Electric Clock, System Moller. M. Tokarsky.	*Elektrits. Nov.* 03.
The New Wheatstone Bridge of MM Hartmann and Braun for Investigating Defects of Cables. S Lopez.	*La Ener. Elect.* 10 12 03.

• Telephonic Central Station System, Ericcson (Serial). E. Gallego. (Concluded 25/12/03.)	*La. Ener. Elect.* 10/12/03.
Attachments for Indicating Occupation of Subscribers' Wires with Multiple Switches. W. Knobloch.	*Elek. Ansr.* 10/12/03.
The Multiplication Rod, being a Wave-Meter in Space Telegraphy. A. Slaby.	*Elek. Zeit.* 10/12/03.
• Methods of Signalling and Operating in Telephone Exchanges (Serial II.). C. S. Winston.	*Elec. Wld. & Eng.* 12/12/03.
Double Hughes Service and Simultaneous Telegraphy in Double Wires. H. Pfitsner.	*Elek. Zeit.* 17/12/03.
Novel Experiment in Wireless Telegraphy through the Ground. G. J. de Guillén Garcia.	*La. Ener. Elect.* 25/12/03.
Telephone Transmitters (Serial II.). A. V. Abbott.	*Elec. Wld. & Eng.* 26/12/03.
The Exchange of the Frontier Telephone Co., Buffalo, N.Y. V. Hayden.	*Elec. Rev. N.Y.* 26/12/03.
Microphone Circuit for Improved Sound Transmissions. F. Merk.	*Elek. Ansr.* 31/12/03.
Rowland Telegraph Apparatus (Concluded). A. Colonna.	*L'Elettr. Dec.* /03.
Wireless Telephony. M. Marchesini.	*L'Elettr. Dec.* /03.
• Methods of Signalling and Operating in Telephone Exchanges (Serial III.). K. B. Miller and C. S. Winston	*Elec. Wld. & Eng,* 2/1/04.
The Effect of Wireless on Improvement in Wire Telegraphy. J. B. Baker.	*Elec. Wld. & Eng.* 2/1/04.
Telephone Transmitters (Serial III.). A. V. Abbott.	*Elec. Wld. & Eng.* 2/1/04.
Automatic Telephone Exchange. L. de Kermond.	*L'Elect.* 2/1/04.
The Localization of Breaks in Submarine Cables. A. Davidson.	*Elec. Rev.* 8/1/04.
Telephone Transmitters (Serial IV.). A. V. Abbott.	*Elec. Wld. & Eng.* 9/1/04.
The National Observatory. New Year's Greeting to the World.	*Elec. Rev. N.Y.* 9/1/04.
Present Conditions in Telephony. F. W. Jones.	*Elec. Rev. N.Y.* 9/1/04.
The Telephone in 1903. C. J. H. Woodbury.	*Elec. Rev. N.Y.* 9/1/04.
Major Wireless Telegraph Progress in 1903. J. B. Baker.	*Elec. Rev. N.Y.* 9/1/04
Automatic Telephone Service in Grand Rapids, Mich.	*Westn. Elec.* 16/1/04.
Free Telephony in 1903. A. R. Bennett.	*Elec. Times,* 21/1/04.
The New Automatic Telephone Exchange at Grand Rapids. E.J. Hart.	*Elec. Wld. & Eng.* 23/1/04.
Wireless Telegraphy. R. G. Blaine.	*Elec. Eng.* 29/1/04.
Multiple Telegraphy. G. Dubreuil.	*L'Electn.* 30/1/04.

Papers.

The Efficiency of Modern Telephone Equipment.	*Chicago Elec. Assoc.* 8, 9, 10/12/03.
On the Differential Telephone. Prof. W. Duane.	*Amer. I.E.E.* 8/12/03.

Electro-Chemistry.

Articles.

Two New Forms of Electrolytic Cell for Production of Bleaching Solutions.	*Elec. Rev.* 25/12/03.
Development and Present State of Electro-Chemistry (Serial, continued Jan.) Dr. A. Neuburger.	*Elek. Zeit. Dec.* /03.
• On the Transformation of Thermo Chemical Energy into Voltaic Energy. D. Tommassi.	*L'Elect.* 16/1/04.

Papers.

The Commercial Electrolysis of Water. J. W. Richards.	*Amer. Electro. Chem. Soc. N.Y.* 26/1/04.
The Thermo-Chemistry of Electrolytic Dissociation. C. J. Reed.	*Amer. Electro-Chem. Soc. N.Y.* 26/1/04.

Electro-Physics.

Articles.

Graphical Representation of Steinmetz Formula. A. Beloj.	*Elektrits. Nov.* /03.
Radio Active Bodies and Tail of Comets. W. Boys.	*Elektrits. Nov.* /03.
The Measurement of the Form Factor of an Alternating Voltage. P. Rose and A. Kühns.	*Elek. Zeit.* 3/12/03.
Selenium Apparatus. Reilmer.	*Elek. Ansr.* 14/12/03.
Novel Measurer of Difference of Phase. A. Biandi.	*Elek. Zeit.* 24/12/03.
Measuring Field Strengths by means of Bismuth Coils. O. Kirstein.	*Elek. Ansr.* 25/12/03.
Effect produced in a Circuit by Rupture of Short Circuit. S. Gallego.	*La Ener. Elec.* 25/12/03.
Theory of Commutation of Current. K. Pichelmayer.	*Elek. Zeit.* 31/12/03.
Determining Insulating Power of Liquids. P. Hamann.	*Elek. Zeit.* 31/12/03.
Electrochemical Reduction of some Nitro Bodies (Concluded Jan. /04.) Joh. Möller.	*Elek. Zeit. Dec.* /03.
Great Magnetic Disturbance on October 31st, 1903. Dr. C. Carpini.	*L'Elettr.* 1/1/04.
Radium. M. Marchesini.	*L'Elettr.* 1/1/04.
Conduction-meter with Direct Reading by Appleyard. F. Guarini.	*Elektro. Rundsch.* 1/1/04.
Novel Selenium Apparatus.	*Elektro. Rundsch.* 1/1/04.
Photographic Wave Forms with the Oscillograph. F. C. Perkins.	*Elec. Rev. N.Y.* 2/1/04.
Construction and Use of Novel Opthalmological Electromagnets. W. Volkmann.	*Helios.* 6/1/04.
Law of Electric Perforations. C. Baur.	*Elek. Zeit.* 7/1/04.
Radioactivity and Electronic Theory. D. Isaachsen.	*Elektro. Tids.* 8/1/04 *(contd.* 27/1/04)
Graphical Evaluation of Magnetic Fields. G. König.	*Elek. Anzr.* 14/1/04.
Routine Electromechanic Compounding System. F. Brock.	*Elek. Zeit.* 14/1/04.
Some Causes of Supertension in High Tension Plants. Dr. G. Benischke.	*Electro. Rundsch. Frankfurt a/m.* 15/1/04.
Hysteresis Work. E. Kretschmar.	*Elektro. Rundsch.* 15/1/04.
Magneto-elastic Detector. C. Carpini.	*L'Elettr.* 15/1/04.
Distribution of Field in the air gap of Weiss & Faraday Electromagnets. Dr. O. Scarpa.	*L'Elettr.* 15/1/04.
Tesla or Ferraris? G. Banti.	*L Elettr.* 15/1/04.
A New Potentiometer.	*Elect.* 16/1/04.
Accuracy and Working of Hartmann and Braun Resonance Instruments. Dr. A. Hartmann-Kempf.	*Elek. Zeit.* 21/1/04.
A Method of Photographing Alternating Current Wave Form. C. J. Spencer.	*Elec. Wld. & Eng.* 23/1/04.
Radio Activity and Radiation. Dr. Louis Bell.	*Elec. Wld. & Eng* 23/1/04.
The Choice of Air Gap Diameter for Induction Motors. H. M. Hobart.	*Elec. Wld. & Eng.* 23/1/04.
A Novel Röntgen Interrupter. H. F. Kettler.	*Helios.* 27/1/04.
Electrical Foucault Pendulum Systems. E. K. Adams.	*Elec. Wld. and Eng.* 30/1/04.
The Theoretical Determination of Power Curves. W. J. Berry.	*Elec. Wld. and Eng.* 30/1/04.

Heat Absorbed in Electrolysis of Salts and Principle of Maximum Work. D. Tommassi.	*Elek. Zeit. Jan. /04*
Electrochemistry in 1903. Dr. M. Krüger.	*Elek. Zeit. Jan. /04.*
Electrodeless Annular Currents. J. Härden.	*Physik. Zeit.* 1/2/04.
Induction in Vacuum. J. Härden.	*Physik. Zeit.* 1/2/04.
Ionisation in Flames. F. L. Tufts.	*Physik. Zeit.* 1 2/04.
Starting of Electric Arc on Metal-oxide. J. Stark.	*Physik. Zeit* 1 2 04.
Polarisation of Röntgen Rays. R. V. Lieben.	*Physik. Zeit.* 1/2 04.
Graphical Evaluation of Magnetic Fields. Conclusion. G. König.	

Papers.

Dielectric Cohesion and Temperature of Gases M. Bouty.	*French Phys. Soc.* 4/12/03.
The Suppression of Magnetic Hysteresis by an Oscillating Magnetic Field.	*Acad. des Scs. Paris.* 14/12/03.
A Simple A. C. Frequency Recorder. Prof. E. S. Johonnott.	*Amer. Assoc. Advan. Science.* 29 12/03.
On the Velocity of Light in a Magnetic Field. J. Mills.	*Amer. Assoc. Advan Science.* 30/12/03.
A Method for the Determination of Mutual Induction Coefficients.	*Amer. Assoc. Advan. Science.* 30/12/03.
On the Electrical Resistance of Hydrogen Charged Palladium. Prof. W. E. McElfresh.	*Amer. Assoc. Advan. Science.* 30/12/03.
On the Charges given to surfaces by the Diffusion of Ions and the Earth's Negative Potential. Prof. J. Zeleny.	*Amer Assoc. Advan. Science.* 30/12/03.
Absolute Value of Magnetic Elements. M. Moureaux.	*Acad. des Scs. Paris.* 4/1 04.
Radium and its Meaning. Sir Oliver Lodge.	5/1/04. *Bhm.*
The Revelations of Radium. Dr. G. B. Batten.	*Rönt. Soc.* 7/1/04.
Action of X Rays on Animal Tissues. MM. R. Lepine & Boulud.	*Acad. des Scs. Paris.* 12/1/04.
The Magnetic Dispersion in Induction Motors, etc. Dr. H. Behn-Eschenburg.	*Inst. E.E.* 15 1/04.
Electro Rectifier and Interrupter. W. Scheidel.	*North-West Elec. Assoc.* 21/1/04.
The Photographic Action of Radium Rays. S. Skinner.	*Phys. Soc.* 22/1/04.
Some uses of the Oscillograph. D. K. Morris & J. H. Catterson Smith	*Inst. E.E. Bhm.* 27/1/04.
Note of Harmonics in Three-Phase Working W. Tatlow.	*Inst. E.E. Dublin.* 28/1/04.
Electric Osmosis in Ammonia Liquids. M. Ascoli.	*Acad. des Scs. Paris.* 28 1/04.

Electro-Metallurgy.

Articles.

Electrolytic Apparatus. D. F. M. Perkin	*Elek. Zeit. Dec. /03.*
• Electric Furnace, Origin, Development and Uses (Concluded). Ad. Minet.	*Elek. Zeit. Dec. /03.*
Electrolytic Antifriction Metal. J. Rieder.	*Elek. Anzr.* 13/12/04.
Electro Metallurgical Works at La Praz.	*Elec. Chem. & Metalgt.* Jan. 04.
Electrolytic Methods for the Production of Copper Wire.	*Elec. Chem. & Metalgt.* Jan. /04.

Papers.

Electric and Magnetic Separation of Minerals M. Korda.	*Soc Inter. des Electrs.* 6 1/04.
Notes on Aluminium Welding. S. Cowper-Coles.	*Faraday Soc.* 2/2 04.
Some Applications of the Theory of Electrolysis to the Separation of Metals from one another. A. Holland.	*Faraday Soc.* 2/2/04.

Students.

Articles.

The Education of an Electrical Engineer. W. G. Rhodes.	*Elec. Rev.* 15/1/04.
The Equipment of a Sub-station with Rotary Converters. O. J. Davis.	*Inst.E.E. (Students)* 20/1/04.

Papers.

Relation of Higher Mathematics to Engineering. Prof. C. A. Waldo.	*Amer. Assoc. Advan. Science.* 28/12/03.
Scientific Investigation and Progress. Pres. Ira Remsen.	*Amer. Assoc. Advan. Science.* 29/12/03.
Some Observations on Mechanical Training. W. D. Hamilton.	*Glasgow Tech. Sc. Soc.* 23 1/04.
The Money Value of Technical Training. J. M. Dodge (President).	*Annual Meet. Amer. Soc. Mech. Eng.*

Manufacturers.

Articles.

Works Visits (II.). Royce, Ltd.	*Elec. Wld. & Eng.* 11/12/03.
• Calculation of the Apparent Inductance in Armature Coils (Serial V. Concluded).	*Elec. Wld. & Eng.* 12/12/03.
New Forms of the Steam Turbine (Serial 1). R. H. Smith.	*Engr.* 18/12/03.
Works Visit (III). W. T. Glover & Co.	*Elec. Eng.* 18/12/03.
Switch Construction. N. C. Woodfin.	*Elec. Rev.* 25/12/03.
• Dynamo Construction in Germany. (Serial II. Continued 10/1/04). C. F. Guilbert.	*La Rev. Tech.* 25/12/03.
Preparation of Estimates.	*Eng.* 1/1/04.
Electrical Speed Indicators: Some Unsuccessful Attempts. A. S. Cubitt.	*Elec. Eng.* 1/1 04.
Applications of a Property of Dynamos in Series. Dr. O. M. Corbino.	*L'Elettr.* 1 1 04.
Testing Large Alternators. W. E. Burnand.	*Elec. Wld. & Eng.* 2/1 04.
Design and Manufacture of High Tension Cables. J. Schmidt.	*Elek. Anzr.* 6/12.04. (concld. 17/1/04.)
Determination of Output of Galatti Asynchronous Motor. G. Sartori.	*L'Elettr.* 8/1/04.
The Design of Motor Starting Rheostats.	*Elec. Wld. & Eng.* 9 1 04.
Works Visits (IV.). General Electric Co., Salford.	*Elec. Eng.* 22/1/04.
The Design of Direct Current Machinery. (Serial, concld.) V. A. Fynn.	*Elec. Rev.* 22 1/04.
Electrical Manufacturing Works Societe Alsacienne Belfort.	*L'Ind. Electr.* 26/12 03.
Continuous Current Dynamos. J. W. Burleigh.	*Elec. Eng.* 29/1 04.
Alternating Current Generators. C. C. Paterson.	*Elec. Rev.* 29/1/04.
Magnetic Tests of whole sheets of Iron.	*Eng.* 29/1/04.
A Curious Turbo Generator. G. Dary.	*L'Electn.* 30/1/04

Papers.

Recent Developments in the Construction and Working of Gas Engines. Prof. D. S. Capper.	*Junior Inst.E.* 4/12 03.
The Electrical Exhibits of the St. Louis World's Fair. Prof. W. E. Goldsborough.	*Amer. I.E.E.* 8/12 03.
Standardization of Construction. F. C. Polk.	*Chicago Tel. Assoc.* 9 12/03

ron Losses in Loaded Transformers. Prof. E. E. Johonnott.	*Amer. Assoc. Advan. Science.* 29 12/03.
The Design and Construction of the Electric Tramway Car. R. H. Simpson.	*Rugby Eng. Soc.* 7/1/04.
Coil Winding for Electrical Purposes. R. Varley & C. R. Underhill.	*North-West Elec. Assoc. U.S.A.* 20/1/04.
Standard Practice in A. C. Electrical Apparatus. J. J. Gibson.	*North-West Elec. Assoc.U.S.A.* 21/1 04.
Steam Turbines. James Lyman.	*North-West Elec. Assoc.U.S.A.* 21 1/04.
Induction Motors. Prof. E. W. Marchant.	*Liverpool Eng. Soc.* 27/1/04.
Steam Turbines. D. Chilton.	*Inst. E.E. Manch.* 2/2/04.
The Constructional Deficiency of a Fleming 4 Valve Engine, directly connected to a 400 k.w. Generator. B. T. Allen.	*Ann. Meet. Soc. of Mech. Eng.*

Central Station Practice.

Articles.

Fall of Potentials of Alternators (Continued Dec. 13th). R. Walther.	*Elek. Anzr.* 6 12 03.
Notes on Engine Driving (Concluded 18/12/03). F. T. Callis.	*Elec. Rev.* 11 12 03.
Central Station Economies. G. R. Parkinson.	*Elec. Rev.* 18 12 03.
When an Engine becomes a Pump. W. H. Wakeman.	*Electy. N.Y.* 4/1/04
Collapsing Pressure of Tubes and Flues. W. H. Wakeman.	*Electy. N.Y.* 4/1/04.
An Emergency Switch or Master for Preventing an Excessive Current Input from Electric Distribution System. G. Stade.	*Helios.* 6/1/04. *(concld.* 13/1/04.*)*
Short Circuits and Electric Plants. St. V. Fodor.	*Die Elektr.* 7/1/04. *(contd.* 29/1/04.
Losses in Copper and Utilizability of Double Current Generators. F. Horschitz.	*Elek. Zeit.* 14/1/04.
Central Stations. W. M. Thornton.	*Elect.* 16/1 04.
Care and Management of Storage Batteries. E. Lyndon.	*Elec. Rev.* 23/1/04.
Excitation of Alternators. F. H. Davis.	*Elec. Eng.* 29/1 04.
Steam and Internal Combustion Engines for Central Station Work. N. McCarty.	*Elec. Rev. N.Y.* 30/1 04

Papers.

Economical Steam Raising. R. B. Hodgson.	*Staffs Iron and Steel Assoc.* 12/12/03.
*Main and Auxiliary Steam Pipe Works for Power Stations. B. M. Jenkin.	*Inst.M.E.* 14/12/03.
The Economy of Superheated Steam. E. M. Reynolds.	*Rugby Eng. Soc.* 17/12/03.
Automatic Apparatus for Regulating Generator and Feeder Potentials. E. J. Bechtel.	*Inst. E.E.* 18/12/03.
Turbines from a Central Station Point of View. L. Gerard.	*Soc. Belge d'Electrs.* 19 12/03.
Coal Consumption in Electricity Works. A. S. Giles.	*Manch. I.E.E.* 19/1/04.
Voltage Regulation in Alternate Current Plants. H. S. Meyer.	*Liverpool Eng. Soc.* 20/1/04.
Alternators in Parallel. H. Bohle.	*Leeds I.E.E.* 21/1/04.
Storage Batteries for Central Stations. J. M. S. Waring.	*North - West Elec. Assoc. U.S.A.* 20/1/04.
Rectifiers. W. Scheidel.	*North-West Elec. Assoc.* 20/1/04.
Double Current Generators W. L. Waters	*North-West Elec. Assoc.* 21/1/04.

Trade & Commerce.

Papers.

The Crisis in German Electrical Industry.	*Soc. C.E. France.* 4/12/03.

Finance and Legislation.

Articles.

Some Fictitious Figures Supplied by Municipal Engineers. E. Kilburn Scott.	*Elec. Rev.* 18/12/03.

Papers.

On the Rights and Liabilities of Electrical Contractors. R. Tweedy Smith.	*Lond. Elec. Contrs. Assoc.* 3/2/04.

◆

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

◆ ◆

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, *with names and addresses of manufacturers, will be given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.*

◆

Power.

Cranes.

CHAMBERS, SCOTT & CO., Dalziel Engineering Works, Motherwell. This firm manufacture overhead electric travelling cranes, which are well described in a small booklet issued by them. Among the special features of the design are bushed bearings, no over-hung wheels, all gearing placed between cheeks and the reduction of the number of gears to a minimum. Electric winches, hauling gears and coal-cutting machines are also manufactured.

Coal-Cutting Machines.

MAVOR & COULSON, LTD., 47 Broad Street, Mile End, Glasgow. An elaborate brochure, bound between red covers, contains an interesting description of the "Pick Quick" Coal Cutting Machine, which has now been a speciality of this firm for some years. Full illustrated details are given of the apparatus, a number of excellent half-tone blocks depicting the various parts being included. Several interesting diagrams show the method of application of the coal cutter, under varying working conditions. Diagrams of connections and curves of performance are also included. Fuller details will be found in our Manufacturers' Section.

Traction and Transport.

Tramway Systems.

THE "G.B." SURFACE CONTACT CO., Hamilton House, Bishopsgate Street Without, E.C. The Surface Contact system recently introduced by this firm is fully described in the Manufacturers' Section of this issue. A neat brochure emanating from the offices of the company, describes in detail the principle and working of the system.

Lighting and Heating.

Accessories.

THE SIMPLEX STEEL CONDUIT CO., 20 Bucklersbury, E.C. Among the latest productions of this firm is a neat diary, prefaced with particulars of the tubing, junction boxes, elbows and switches, also a price-list of fittings and accessories, the whole forming a handy guide for wiring contractors. The diary has an alphabetical thumb index and is neatly bound in leather. The "Unimatic" loose leaf book has also been sent us, and this we find an extremely useful aid in our everyday business, as in addition to an alphabetical thumb index, the cover, which is of leather, encloses a quantity of loose sheets, held in by the special clip, which engages with punched holes in the leaves. These are released by pulling a rod. The device emanates from America.

Manufacturers'.

Miscellaneous.

FULLER-WENSTRÖM ELECTRICAL MANUFACTURING CO., 110 Cannon Street, E.C. A blotter, with diary attached, has been issued by this Company, and it fills a useful place on our desk. A £1,000 accident insurance coupon accompanies the blotter, a portion of which also contains several pages of useful information.

Distribution.

Cables and Mains.

CALLENDER'S CABLE & CONSTRUCTION CO., LTD., Hamilton House, Victoria Embankment, E.C. A handy book of some 130 pages describes the tramway pillars, junction service and dividing boxes constructed by this company. The book is neatly illustrated with sections of the various types of junction boxes, and full details and particulars are tabulated opposite each item. The booklet is handy for carrying about and will prove useful in the pocket of any mains engineer. The same firm has compiled, from photographs taken in all parts of the world, an interesting brochure showing the laying of Callender cables under all climatic conditions, and with almost every class of labour.

THE BRITISH INSULATED HELSBY CABLES, LTD., Prescot, Lancs. The neat circular paperweights, in which a section of concentric cable is embedded, which have been issued by this firm, will doubtless have found their way to the tables of many central station engineers. We have been pleased to welcome same as a useful device on our own tables.

THE LIVERPOOL ELECTRIC CABLE CO., LTD., Vauxhall Road, Liverpool. We have received from this Company a neat tear-off calendar, got up in first-class style.

W. T. HENLEY'S TELEGRAPH WORKS CO., LTD., Blomfield Street, E.C. A calendar has also reached us from this firm, who differentiate in supplying, instead of the usual tear-off type, an almanack with movable cards.

W. T. GLOVER & CO., LTD., Trafford Park, Manchester. This firm have again issued their interesting calendar, with daily tear-off sheets containing excerpts from the Proceedings of the Institution of Electrical Engineers. We have been favoured with several copies, and have therefore been able to examine the contents in advance.

Miscellaneous.

Typewriters.

THE SMITH-PREMIER TYPEWRITER CO., Gracechurch Street, E.C. We have received a well illustrated monthly tear-off calendar from this firm.

Accumulators.

THE HART ACCUMULATOR CO., LTD., Marshgate Lane, Stratford, E. A handy blotting pad has been issued by this firm.

TRADE NOTICES.

SINCE January 1st, 1904, the business of The Electrical Transmission Co., Albert Works, Hammersmith, has been amalgamated with that of The Sturtevant Engineering Co., Ltd., whose works are at Bankside, S.E., their chief offices being 147 Queen Victoria Street, E.C.

THE LAHMEYER ELECTRICAL CO., 109 New Oxford Street, W.C., having completed arrangements for the purchase of the patent Schuler single phase A.C. motor, are now in a position to supply these

WALKER & HODGETTS, LTD., Electrical Engineers, St. Simon's Electrical Works, Salford, have secured the services of Mr. H. W. Clothier, who will undertake the development of their business on up-to-date lines. Mr. Clothier was recently manager of the estimating department, Ferranti, Ltd., and, as our readers are doubtless aware, played a prominent part in the switch works of that firm.

Forthcoming Events

A complete list of the meetings of various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, will be listed under order of date in this section.

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

April 30th to December 1st, 1904.

Electrical Exhibition, Warsaw.

May to September, 1904.

Third International Congress of Mathematicians, Heidelberg.

August 8th to 13th, 1904.

Industrial Exhibition, Cape Town.

November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

THE date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition. The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

Papers before Societies, etc.

Regulating Impedance Coils.

C. F. Proctor, Newcastle Inst. E.E. *Feb. 29th, 1904.*

The Mersey Railway, Multiple Control System.

H. L. Kirker, Manchester Inst. E.E. *March 1st.*

Parson's Steam Turbine.

G. L. Parsons, Newcastle Inst. E.E. *March 21st.*

Meetings, Conventions, etc.

I.E.E., Manchester Section.

Annual Dinner. *February 26th, 1904.*

American Electro-Chemical Society, Washington.

April 7th, 8th, 9th, 1904.

National Electric Light Association.

27th Annual Convention, Boston. *May, 1904.*

Books.

Radio-Activity, by Fredk. Soddy, M.A.

Dynamo, Motor and Switchboard Circuits.
Crosby Lockwood & Son.

An Acknowledgment.

THE Editor of *The Electrical Magazine* is indebted to the Editor of *Garcke's Manual of Electrical Undertakings* for the figures given in the paragraph anent "The Advance of the Electrical Business in Great Britain," on the first page of our leading article (page 1 No 1 of *The Electrical Magazine*). These figures were compiled by the Editor of the *Manual of Electrical Undertakings* with the care and accuracy which always characterise the information given in that valuable Annual, and the courtesy of its Editor is strikingly demonstrated in supplying *The Electrical Magazine* with the figures prior to the publication of the *Manual*. Our readers will find further information in the pages of the work in question, which contains a mass of valuable material not published elsewhere, and we understand that this year it has been considerably enlarged. Certainly, every man connected with Electrical Engineering should be possessed of this monumental volume, which is practically indispensable as a reference guide.

The figures above referred to were supplied to us when the last sheet of *The Electrical Magazine* was on the press, and owing to the rush on our time and space, the ordinary acknowledgment was inadvertently omitted in our pages. We think it, therefore, only right to give full credit in this special manner to the enterprise of our esteemed contemporary.

The
Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

No. 3. Vol. I. London. March 25, 1904.

THE POSITION OF THE ELECTRICAL INDUSTRY.

It is customary for most business concerns at this time of the year to take stock of their undertakings, and in the same way it may not be out of place for us, whose chief concern is the welfare of the electrical industry, to consider briefly its present position. We cannot discuss that position in detail, showing every factor entering into it, as if it were an entry on a balance sheet. Rather must we be content to take a general view, and note particularly only one or two points which, from their importance, deserve special attention.

Every advance made in the applications of electricity, and every little extension of the area of supply of this commodity to the public, involve a demand for further plant from the manufacturer, so that from the state of the manufacturing section we might expect to learn whether general progress is in fact being made. This is, as we shall see immediately, only partly true, but, taking it for the moment as the whole truth, what is the present position of the manufacturer? At first sight it does not seem encouraging. A glance at the reports recently issued by manufacturing companies shows that in many cases shareholders have had to be content with reduced dividends, and from various quarters come complaints of dullness and depression of trade. If we were to confine our attention strictly to the electrical trade, this state of affairs would be far from satisfactory, but its very existence compels us to look around to see what is happening in other manufacturing industries. To find them flourishing while our own particular industry showed signs of stagnation would give cause for serious consideration whether all was being done that might be done by those responsible for its organisation; but if we find that the same depression exists elsewhere, there will be less cause for anxiety. And little investigation is needed to discover that at the present time there exists a universal depression. In every quarter one hears the same complaint of dull trade and scarcity of money, and the difficulty of floating new issues or new loans is fully recognised. Thus the electrical industry is only sharing in a general misfortune, and is not, we believe, the worst sufferer. The extension of electricity supply, requiring, as it does, a large amount of capital, must naturally be delayed so long as the money market is in its present condition; for not even local authorities can venture to incur fresh debt to any extent at this moment. These bodies are, in fact, themselves largely responsible for the present state of affairs, as the alarming rate of increase of municipal indebtedness has caused much anxiety in financial circles. It may be said that we ought not to complain, as a large proportion of that debt has been incurred for electrical enterprises; but the answer is that the same enterprises could have been carried on better without municipal intervention, and, had this been done, the same, or even greater, capital would have been provided, but without taxing the people and bringing municipalities to the verge of bankruptcy.

There is, however, another reason for the present falling-off in dividends in electrical manufacturing concerns. In few, if in any, industries is foreign competition more keen, and in recent years this competition has become more and more serious. Germany and America are cutting prices as much as possible, and as we are prevented from adopting their own methods in these countries the result is all the more serious to our manufacturers. This state of affairs may be altered ere long, and then we shall be able to compete on fairer terms. If we "go under" in that fight we will have none but ourselves to blame, but let us at least have the chance of a fair field.

It is interesting to notice how other countries look upon this struggle for supremacy in the electrical industry, and we may therefore refer here to a suggestive article which recently appeared in the *Elektrotechnischer Anzeiger.* The writer, Dr. Emil Kreller, there discusses the development of the electrical industry in Germany, and analyses the position of this industry in other countries. His general conclusion is that the United States of America is the only serious competitor with Germany, and that for the future all the factors, except cost of labour, are in favour of America. In England, France, and Belgium, he says, want of organisation in manufacture has given Germany a lead which will not easily be taken from it. Even if we accept the assertion that Germany has gained a lead over us, we do not for a moment admit that the cause is that attributed by the writer. It is, in fact, to be found elsewhere—and principally in our legislation—but we pass over this to notice particularly the writer's recommendation. In his view America is forging ahead under circumstances likely to give that country a long lead. What, then, should be done? Dr. Kreller hopes that an understanding may be come to between the two countries, by which Americans and Germans will divide the world's markets for electrical goods, and so avoid a ruinous competition. Is there not something suggestive here? Is it not typical of German methods? Her own industries are protected against foreign competition at home, but in foreign markets she finds a competitor becoming too strong, and therefore approaches that competitor to strike a bargain. If this were done, England would be the chief foreign market for those countries, and what would be the outlook for the English electrical industry? Surely, then, it is necessary to do something to prevent our country becoming the happy hunting ground of our commercial rivals. At the present time our manufacturers are doing what they can, and some are now in close relations with American and German firms; but Government assistance is necessary to enable our industry to hold its own with its foreign rivals. We do not suppose America is likely soon to make bargains of the kind just indicated, but if she did so, she would prefer to bargain with this country rather than with Germany. So long, however, as we hold to our present fiscal policy, no country has anything to gain by bargaining with us.

It is the existence of this foreign competition which prevents the state of electrical trade at home being a true guide to the progress being made in the distribution of electricity. Many orders for British installations have been placed abroad, the worst offenders in this respect being again the municipalities. They do not scruple to enforce conditions upon British manufacturers which they cannot, and do not attempt to, enforce on foreign firms, and yet are bold enough to boast of the economy they gain thereby! Truly the municipal conscience is a wonderful thing! The fact that, in spite of municipal obstruction and of unfair competition, we find the industry so far advanced as it is, gives the best evidence of its vitality and a guarantee of rapid progress when once the artificial restrictions are removed.

[*The above is the first of a series of leading articles by eminent experts. The Editor of* "*The Electrical Magazine*" *does not necessarily identify himself with the views of the writers.*]

The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month.

* * *

This section will consist of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They will be mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

* * *

Appreciation and Thanks! THE enthusiastic reception accorded our first number was maintained in an equally striking manner with the issue of the second. Congratulatory letters have almost overwhelmed us, and we are quite unable to present our readers—much as we should like to do so—with even the cream of these. A few striking examples are reproduced on another page. With such spontaneous support from all quarters, we can substantiate our claim to a premier position among technical electrical journals. This magazine has leapt at once into favour, and we anticipate an even greater welcome for its succeeding issues. To our readers the world over our best thanks are extended.

* * *

The Crystal Palace Show. As a display of mechanically propelled vehicles, the recent Automobile Show must have impressed all visitors, but to the electrician the overwhelming preponderance of the petrol car would, doubtless, be disappointing. The electric vehicle, much boomed, is notoriously slow in its development, though its progress seems none the less sure. Evidently its ultimate appearance will be the outcome of evolutionary rather than revolutionary laws—a noble representative of a long line of ancestral types, each the outcome of its predecessor. We have now become patient in our hopes and anticipations of cheap batteries; more or less confident that futurity holds some little surprise in store. For the present, we must be content to play a second, though indispensable, part in automobile work, while our "electric forty milers" ply busily amid metropolitan traffic. A supplement to the Manufacturers' Section this month gives illustrated particulars of the electric car exhibits, and the accessories for petrol ignition purposes.

* * *

Advance, New Zealand! OUR colonial friends in New Zealand are evidently watching closely the development of natural power sources in other countries, presumably with the idea of discovering some reflex of the same in their own country—their wonderland, as they are proud to call it. America has hopes of operating an electric railway in the Yellowstone National Park by energy derived from hot springs or boiling water drawn from borings into the earth's surface. The reception of this information in New Zealand at once raises similar hopes of obtaining power from the hot and cold springs of Rotorua, where it is suggested that experiments should be carried out. The lighting and transit problems of those little islands might then be solved by other means than hydro-electric power. Meantime we in this country are condemned by Nature to dig coal and convert it by indirect methods into electrical energy. Some nations are truly favoured of the gods!

Light Bakery!

"To bake or not to bake, that is the question" in underground bakehouses in Fulham. The Borough Council has wisely refused to grant certificates for underground bakeries, unless fitted with electric light, and a delinquent was recently fined despite his objections on the score of the condition being "unreasonable and not enforced in other boroughs." Rabid anti-municipalites may denounce the council's action as tyrannical, but all citizen lovers of cleanliness and "light" bread must accord their approval of a regulation which, in our opinion, would bear strict enforcement wherever electric light is available.

Guernsey Telephones.

The report for the year ending December 31st, 1903, indicates an increasing prosperity. There are now 1,217 instruments working in the island, making a proportion of one to every thirty-three people, which shows that Guernsey is the best telephoned area in the United Kingdom. The cost per line works out at £17 9s. 5d., and the net profit, after allowing for sinking fund and depreciation, as well as a special contingency fund, is £201. The special feature of interest in connection with Guernsey is that it shows how successfully a telephone system can be operated in an agricultural district. It is noteworthy that the year under review is the sixth year of the undertaking, and completely falsifies the prophesies of critics who foretold a collapse at the end of the third year.

Where Electricity Scores.

English steam railways are hardly likely to suffer inconvenience or loss of schedule time through the "freezing up" of locomotives, especially under such climatic conditions as have lately prevailed. Heavy snow storms and zero weather early in the year caused serious traffic delay in New York City, when locomotives standing three or four hours in the cold were discovered with boiler water frozen, and until thawed were useless for service. The electric railways and trolley lines meantime were operating practically on time after a few snow ploughs had cleared the road. We do not anticipate a like calamity for even the smallest of our railways, though the comparison between steam and electricity, to the disadvantage of the former, under exceptionally severe conditions, should not be lost sight of.

A Use for Canals.

A correspondent, who signs himself "Advance," in a somewhat vague communication suggests that our canals or rather the land they cover, be utilised for electric tram and rail roads, *after draining off the water*. By his scheme the derelict canals are to be purchased, and high speed electric roads laid on the bed of the present waterway. He points out that the Gloucester and Ledbury line was laid by the Great Western Co. in this way, and attributes a similar object to the same Company in acquiring the Simpley, Stoke and Bristol Canal. The possibilities of the proposal may, or may not, appeal to railway companies owning canals, though doubtless it has occurred to some of them to thus turn an otherwise almost dead asset to good account. We, however, anticipate a future for electric towage on our canals, and electric traction on main railway lines, the former to be utilised for heavy loads and the latter for high speed passenger traffic. We are, nevertheless, pleased to bring our correspondent's suggestion to the notice of readers.

Italian Trade with South Africa.

Considerable attention is being paid by the Italian Chamber of Commerce in London to the openings for trade provided by our South African Colonies, and to the fact that transport facilities afforded by the German lines of steamships give a considerable advantage to Italian manufacturers. We notice that the Chamber is impressing upon Italians the fact that the present moment is a most auspicious one for the extension of export trade, and that all products intended to add to the comfort of modern life will find a ready market. The special needs of South Africa are pointed out with considerable minuteness, and Italian manufacturers are strongly urged to send competent representatives to ascertain the needs of the inhabitants, and to exhibit samples of their various wares. The report to which we refer affords one more illustration of the intelligent alertness of Continental firms; and it is greatly to be hoped that our own manufacturers will persevere in efforts to retain their hold upon a market which belongs by natural right to this country.

❧

The Future of the Telephone in Great Britain.

THE opinion of the General Manager of the National Telephone Company, that upwards of ten millions of fresh capital will be required within the next few years in further extending the telephones in this country, is a modest one when we consider the enormous lea-way we have to make up. The sum mentioned will only be sufficient to approximately double the number of telephones, whereas, to place this country on a par with America, it would be necessary to provide capital to raise the number to two million telephones, for which fully £40,000,000 (forty millions) will be necessary. The problem is, who is to provide this sum and to operate such a large number of telephones. No single organisation can do it, neither company nor the Post Office. The local authorites must lend a hand, as there is ample room for all. The acquisition of the telephones by the General Post Office would prove to be the financial blunder of the century, and would further arrest the natural development of the enterprise.

❧

A Waterless Niagara!

SEVERAL of our lay contemporaries have recently been exercised as to the power companies operating above Niagara Falls using the water to the extent of "drying" the Falls proper. Figures were, however, given by one daily, showing that such fears were groundless, the works at present contemplated being only able to reduce the flow about 22 per cent., the effects of which would be invisible. The incident recalls a rejoinder of a prominent American electrical contemporary, to the effect that, when the power schemes projected at the Falls were in "full blast," the state of affairs now causing anxiety in the lay press would transpire, and the river bed be left high and dry. Compensation was offered the tourist, in that the works would be graciously closed on certain days, and the water allowed to follow its natural course, temporarily reminding the world of the former splendour of the Falls. Matters will not be allowed to get this length, however, as the Legislative Assembly of Ontario will, we understand, discountenance any movement likely to threaten the existence of one of the world's greatest wonders.

❧

Exit Steam.

BY the time this issue is in the hands of our readers the first electric railway of any length to be opened in this country will be available for public traffic. The action of the Lancashire and Yorkshire Railway Co., in "electrifying" a section of its lines, is worthy of emulation in other quarters, while not the least commendable feature of the step is the placing of the contract with a British firm. The distance covered, 18½ miles, Liverpool to Southport, is a typical section of railway, in which the advantages of electrical operation, especially with the system chosen, will be strikingly evidenced, and we anticipate excellent returns as a result of the change. Much has been said lately on the subject of main railway electrification, but the problem solved by the interurban system referred to, must not be confused with that greater question, to which Mr. Mordey refers in his serial now appearing in these pages. Direct currents, supplied from sub-stations, depending on H.T. polyhase currents, cannot be utilised on lines extending many hundreds of miles, though they answer the purpose well in the system under consideration. In our next issue we shall give illustrated technical particulars of the line and route.

❧

The Coming of One-phase Railways.

IT is interesting to note, especially in view of Mr. Mordey's article in our present number, that a public demonstration of the motor-generator system described in this issue, will be given during Easter, by the Maschinenfabrik Oerlikon, at their works near Zurich. We are informed that this will be made on an experimental track connecting the Company's Works with the Seebach Station on the Swiss State Railways. The experimental line has been equipped in order to obtain experience and settle details for a practical trial to be made on an extended scale on the State Railway line between Seebach and Wettingen, a distance of 20 kilometres, or about 13-14 miles. It would seem that Messrs. Mordey and Jenkin's paper, read in February, 1902, before the Institution of Civil Engineers, is bearing fruit. At that time no electrical concern or company had put forward any one-phase proposal, although it transpired in the discussion that the Oerlikon Co. had been quietly at work on the system now referred to. Since that time most, or at any rate a good many, of the great manufacturing concerns have turned their attention to one-phase working, and there are something more than signs that the prophesy of Mordey & Jenkin will, ere long, be amply fulfilled. Even if England cannot claim to have taken any very prominent part in the actual working out of these problems, it is satisfactory to know that the first clear and definite pronouncement on the subject was made by English engineers.

* * *

Power Supply at One Hundred Million Volts!

We referred in our last issue to the work of Mr. Nikola Tesla, and of his entering the field of professional consultants. Some interesting, not to say startling, details of this work are now to hand in the "treble" number of *The Electrical World and Engineer. En passant* we may mention that the number in question is a magnificent tribute to the labours of electrical men in America during the past 30 years, containing both reviews of the past and forecasts—almost prophecies—of the future. In an article specially written for the issue, Mr. Tesla deals with the transmission of power without wires. Since the summer of 1899, he has pursued some remarkable studies of the laws of propagating currents in the earth and atmosphere, Colorado Springs being the site of his laboratory. In a future issue we shall hope to give further details of his plant and methods, but at the moment we cannot do better than present our readers in Mr. Tesla's own words, with the hopes he entertains for his schemes. "In this first power plant, which I have been designing since a long time, I propose to distribute ten thousand horse-power under a tension of one hundred million volts, which I am now able to produce and handle safely. This energy will be collected all over the globe, preferably in small amounts, ranging from one fraction of one to a few horse-power. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high frequency currents, and in each instance a terminal a little above the roof will be sufficient." Mr. Tesla adds that his first plant, but for vexatious delays—not technical defects—would have been completed ere this, but regards the loss of time as a blessing in disguise. Here we quite agree, as engineers are hardly yet accustomed to the idiosyncrasies of wire transmission plants, but then the "wireless" would eliminate all their troubles, especially with cables. If these prognostications are a sign of what is to come, the *genus* mains engineer will either become extinct or develop a capacity for inspecting aerials in a flying machine!

* * *

To our Student Readers.

We should like to take this opportunity of addressing a few words to our student readers on the subject of our correspondence section, headed: "From Professor to Student." We shall do our very best to answer, as far as possible, all questions of general interest—scientific, technical, and those relating to the training of electrical engineers. As the pressure on our space increases, however, it may become imperative to make a selection of the questions received. We shall in that case give preference to such as deal with scientific and technical matters, and which involve no purely personal interest. We should urge our readers to aim at being as definite as possible in their questions. There is a type of question which, from its very vagueness and generality, does not admit of any satisfactory answer—such as: "What prospects of success are there open to a young electrical engineer?" or, "What are his chances of promotion?" or, "What rate of pay may an electrical engineer with a College training expect after so many years of practical experience?"

While we shall always be ready to assist with our advice any of our readers who has a definite difficulty or who requires some guidance, we should urge our correspondents to abstain from plying us with questions such as those we have just quoted. We refer student readers to p. 298 for further particulars.

❧

Standard Nomenclature for D.C. Machines.

REFERRING to our note on this subject in the January issue of *The Electrical Magazine*, Mr. S. W. Cuttriss, of Leeds, writes to the effect that, while accepting our fourfold division of the various types of machines as at present constructed, he considers a slight alteration would be desirable to the names we proposed. He suggests that the following four terms should be applied to the various types of direct-current machines: "Open," "protected," "ventilated," and "closed." The first and second of these terms are the same as those suggested by ourselves, and the last, being the converse of the first, is thought by our correspondent to imply the condition of air-tightness better than the word "enclosed," at present in general use and included in our own category. He says, also, that as "semi-closed" would naturally imply protection, "ventilated" would be a more distinctive designation for the third type, and, further, that it would suggest the reason for the machine not being "closed." We readily adopt the suggestion that the shorter word is desirable for the fourth class; but in view of the possibility that positive, or mechanical ventilation may shortly be adopted for some classes of machines, we think it might be better not to appropriate the word "ventilated" at the present time. If mechanical ventilation should be adopted, as we have elsewhere advocated, it would obviously give a fifth type of direct-current machine, and application of the term "ventilated" to machines merely provided with openings through which air might circulate with more or less efficiency, would probably lead to confusion. We leave this further point for the consideration of our readers, again inviting their comment. Although we have no regular correspondence column, we are always glad to comment here on all communications received.

The Utilisation of Flood Waters.

THE serious floods which have taken place of late in the Thames Valley, and in many other parts of the country, suggest to every thinking man that measures should be adopted for the storage of surplus waters for use during the summer season. Of course, it very often happens that a totally unnecessary amount of rainfall occurs during the summer time; but this is not always the case, and we frequently suffer severe droughts, causing much hardship to the people, and seriously imparing the efficiency of rivers and canals as highways for traffic. It should be a perfectly simple matter to store up the surplus rainfall of the winter for use in the summer time, in accordance with the practice followed by other countries. In addition to its utilisation for domestic and trade purposes, the water so stored might, in many cases, be applied for the development of power. Although we have not in this country the great differences of level prevailing in Switzerland and elsewhere, there is no reason whatever why intelligent use should not be made of such natural advantages as are possessed in many parts of the United Kingdom. Isolated action by individuals, or even by local authorities, would not be of much use; but comprehensive schemes by Country Councils acting in concert would clearly be of immense service to the community, and, as we have pointed out, should make practicable the development of water power for electrical plant in many parts of the country.

❧

Anent Electric Light Carbons.

ELECTRIC light carbons are being improved, after having lived through many years without perceptible change. Experiments undertaken by Siemens & Halske seem to have resulted in discoveries, which are supposed to be of the nature of improvements. Our old friends, the rare earths, are of course responsible for this departure. The carbons are to be made of thorium or an alloy of thorium with other metals of the rare earths, which is mixed with thorium carbide, and a carbonisable substance, such as paraffin or caoutchouc, added to make a plastic mass. On the face of it, the mixture does not look very hopeful. Thorium carbide is a singularly unstable substance, and unless it is effectively shielded from contact with the air, it is not likely to remain in the condition of thorium carbide for long. As for a carbonisable substance like caoutchouc, we should prefer to do without it, if there is any question of carbonising the mass, and as for the production of metallic thorium, this has not hitherto been done on a commercial scale, though no doubt it is perfectly possible. Probably the oxide is what is actually required, and if the consumption of thoria should be sensibly increased by demands from this source, its price may be expected to rise still further. Last year 1,200 tons of monazite sand were used in Europe in the preparation of thoria, and though 2,000 tons arrived in Hamburg in the course of the year, the price has risen. The American who controls the output of monazite sand in Brazil must have no cause for regret, unless it lies in the fact that other possible candidates for the concession are now urging the Brazilian Government to reconsider the situation.

⁂

Municipal Electric Lighting Finance.

A BRIGHTON ratepayer has recently been writing to the local press complaining bitterly of the town council's proposal to borrow an additional sum of £4,000 to be spent on a change of voltage of supply. It appears that £1,500 was borrowed for this purpose last year, so that altogether a debt of £5,500 is to be incurred for a matter which, as the correspondent points out, is of no benefit to the consumer, however advantageous it may be to the supply authority. The contention of this ratepayer is "that all and every expense connected with change of voltage ought to be charged to the revenue of the undertaking," and we agree with him, especially as much of that expenditure goes to replacing consumers' fittings and lamps—things which are not the property of the undertakers. It may be true, as the engineer's report states, that the change of voltage "would avoid additional feeders, the cost of which would be considerably greater than the cost of changing over;" but when the change is made, the capital value of the plant is not increased as it would be if more feeders were put down. It is to our mind unsound finance to adopt such a plan for carrying out a change of voltage, and as Brighton claims to have made a large profit on its undertaking, the expedient of increasing its indebtedness instead of drawing upon the revenue account, is all the more unjustifiable. If proper charges upon revenue are to be evaded in this way, it may be easy to show "profits," but what is the nature of these profits? The matter is one which the Local Government Board should inquire into very closely, as anything in the nature of unsound finance should not receive its sanction.

⁂

The Present State of the Telephone in this Country.

AN interesting feature of the recent meeting of the shareholders of the National Telephone Company was a report presented by the General Manager on his recent visit to the United States. His statement goes to prove what is already well known, that this country is in an exceedingly backward condition in telephone development. The report does not go far enough into the subject. It is not sufficient to select a few of the larger cities in the States and compare them with cities of a corresponding population in this country. The real comparison is between each country as a whole. Tested in this fashion, there are three and a half million telephones in the States against three hundred and fifteen thousand in this country. The comparison is more striking when worked out on a basis of population, there being one telephone for each twenty-two citizens in America, and one to every one hundred and thirty in Great Britain, in other words there are six times more telephones in the States than in this country. The reasons are not far to seek. Telephony in the States enjoys a greater freedom of development, the Government does not suppress, by needless restrictions, with one hand, while appropriating 10 per cent. royalty with the other. The inauguration of competition in America is again largely responsible for the great development. The upspringing of many competitive Companies in recent years has resulted in a ten-fold increase in the number of telephones. The old and oft repeated untruth that telephony must be a monopoly is torn into tatters by the universal experience that, wherever competition takes place, there follows cheaper rates, lower charges, and large increase in numbers.

❧

Electricity in Mining and Metallurgy.

Some Continental collieries now rely entirely on electric motors for the winning of their coal—the mine winding engines, the mine drainage pumps, the ventilating fans, the underground haulage, the locomotives, the rock drills and coal cutters, and all the subsidiary operations depending entirely on electric power for their operation. This supersession of the steam engine and compressed air transmission has not transpired without expending large sums of money, but the results are justified, and collieries are being converted to electric driving, not from any feeling of sentiment, but because it pays. However, there seems to be some uncertainty of opinion in this country of what the real state of the art is abroad, and bearing in mind the economical aspects of the question, and its interest to electrical manufacturers, we are publishing a special series of articles on "Electricity in Mining and Metallurgy," by Mr. Percy R. Allen, whose Continental connections should add material weight to his descriptions of what is being done abroad in electric transmission in mines, and the equally important application of electricity in Steel and Iron Works. The utilising of blast furnace gas in gas engines coupled to dynamos has placed a source of cheap power at the command of the steel maker, which enables him to drive nearly all his machinery, with the exception of the blowing engines and the trains of rolls themselves, by a motive power generated in the mere act of smelting his raw material.

It is not our intention to minimize or decry what electrical engineers are doing in Great Britain, but it is an undoubted fact that at the present moment in some branches of engineering our Continental competitors are a little ahead of us, and the application of electricity to mining and metallurgical work is a case in point. It will be our policy to closely watch, and collect and present to our readers such data, facts, and figures as will enable reliable deductions to be made why such a state of affairs should exist. The information given in our pages will be of value and interest to the student, the draughtsman, the consulting engineer, the business manager, the capitalist, and the intelligent layman. The second of the series of articles is published this month, and will be found of exceptional interest.

❧

The Metric System.

Our readers may remember that, at the Conference of Colonial Premiers, held in London, in September, 1902, a resolution was passed favouring the adoption of the metric system of weights and measures for use within the Empire. The Colonial Secretary consequently wrote asking for the views of the various Colonial Governments, at the same time pointing out that the resolution applied merely to weights and measures and did not extend to currency. From a White Paper issued this month, we learn that there is a fairly general concensus of opinion favourable to the adoption of the system. For example, Australia, New Zealand, Cape Colony, the Transvaal, the Orange River Colony, Southern Rhodesia, Gambia, Northern Nigeria, and other Colonies, agree to the principle, without qualification. The Natal Government and some smaller Colonies are unprepared to assent to its adoption unconditionally, and no reply has yet been made by Canada. Probably the Government of the Dominion, and of other Colonies in the New World, can hardly be expected to favour the metric system unless the United States are prepared to adopt it, and if this should be the case, negotiations ought to be opened with the Government of the Republic without unnecessary delay. Metrical units are coming more and more into use every year in connection with scientific work, and especially in electrical engineering. With the exception of the United States, they are practically universal among foreign countries, and it is certain that British exporters could lose nothing, and might gain a good deal by the employment of weights and measures with which foreigners are thoroughly familiar. We hope the present Colonial Secretary will not allow this important matter to be dropped.

Technical Training.

The air is full of suggestions, discussions and criticisms respecting technical instruction, and the technical training of engineers. Whatever may be the outcome of the attention which, at the present time, is being paid to this subject, it is to be hoped that we shall discover exactly how we stand in this matter, and how we may best improve our educational position as a nation. Money spent on education is an investment, and if the system be perfect and comprehensive, there can be no two opinions about the value of such an investment. But it should not be forgotten, that the best education a man can get, is that which he gives himself. Our technical colleges and polytechnics are means to an end, and are intended to afford the facilities which deserving students need to assist them to climb the educational ladder. Whatever our short-comings may be educationally, it cannot be denied that the Northampton Institute and the many technical institutions which are now flourishing, are a notable feature in the educational system of this country. Electrical engineering is prominent in the curriculum of this institution, and it is a noteworthy fact, that the staple industries of the district receive first attention, and the Optical and Horological Departments are high class examples of what can be done in providing classes in trade subjects.

One of the chief features of the discussions arising from the deliberations on technical training, is the comparison which is invariably made between the German system of technical education and our own. The instruction afforded by the "Technikum," at Mittweida, for instance, is of two degrees—higher and lower. The former includes training of designers, constructors, manufacturers, managers, consulting engineers and technical commercial travellers, whilst the latter supplies the training for foremen, draughtsmen, and inspectors and skilled mechanicians, etc. Details of the courses of instruction were recently given in a contemporary, and it is satisfactory to learn that, excepting the commercial training, our institutions, such as the Central Technical College, Finsbury, and the Manchester Municipal College of Technology, are doing approximately the same kind of work. The one weak link in our system of technical training is the absence of a satisfactory secondary education scheme.

❧

Vibration and Nuisance.

In our last issue we referred to the recent cases where injunctions have been granted against electric lighting undertakers for nuisance created by vibration, and in looking for a remedy, we dealt with the problem as one for engineers. Since then, the Electricity Committee of the Poplar Borough Council has been considering the matter, and has decided that the best way to solve the difficulty is, not to remove the vibration, but to remove the liability for damage done by it. With this object in view, the Committee wishes to get the authorities for electric lighting throughout the country to combine to petition the Board of Trade to abolish the nuisance clause from provisional orders, and to substitute a clause giving compulsory powers of acquiring land for generating sites. It may be pointed out that the Board of Trade cannot, of itself, do this, and legislation would be necessary to effect the change. Had the Bill of last year become law, these compulsory powers of acquiring land would now have been in force, and perhaps on that account Poplar and other local authorities may see their way to support its re-introduction this year. But apart from this, it is not clear that this change would put an end to nuisance troubles. The undertakers would still be liable at law for a negligent user of their statutory powers, and it is quite possible that a court might hold the existence of vibration in property adjoining a lighting station to be evidence of negligence, if proof were given before it by engineers that such vibration could be prevented. Vibration caused by trains on railways is on a different footing altogether, and gives no evidence *per se* of negligence, so that the railway cases do not help us. But even if no action at law would lie, owners of property would have the right to compensation for their lands being "injuriously affected," and this would lead to extra expenditure by the undertakers. Thus it appears to us that the problem is still one for engineers, and that it should be carefully considered by them. And if the Board of Trade is to be petitioned to change the law, let companies beware of joining with local authorities to secure its alteration *in one detail*; we must have no piecemeal legislation, but a thorough measure of reform, including, like last year's Bill, the abolition of the veto.

Maximum Demand and Free Wiring.

ELECTRIC lighting seems to suffer from various practical inconveniences in everyday life, and things seem to get more complicated instead of simplifying themselves. Thus, for instance, the idea involved in the maximum demand system is by no means easily understood by the common people, and its application to any concrete case by way of explaining its principle seems merely to remove the difficulty one stage, and to require a more extended acquaintance with arithmetical principles than the average man possesses. The unfortunate consumer who does not understand the first thing about his electrical installation, in most cases does what he is told, and merely thinks that the maximum demand system, unintelligible as it is, is not any worse than the shocks he unexpectedly gets from his wall sockets. Still we know, or think we know, that the maximum demand system is good for the electrical engineer, though we cannot explain why all businesses are not conducted on the same lines, seeing that they suffer from similar inconveniences. It is, however, a simplification of the arithmetic and possibly even of the apparatus itself, if that is possible, which is necessary if the system is to survive, and not merely to be a stepping-stone to higher things. Further: the expression "free wiring" should be improved off the face of the earth as speedily as possible. It has probably caused more trouble than most things. Even when it is seen, as is indeed obvious, that the wiring is not done for philanthropic reasons for the purpose of securing the ordinary profit from the supply of electricity at the ordinary rate, the system under which payment is made is not always equitable, and looks too much like a glorified money-lending business. The well-known hire systems, or methods of deferred payment, seem far preferable, and lend themselves to none of the ambiguities of the so-called "free wiring." Many of the free wiring schemes are in fact nothing more nor less than systems for deferred payment; and there would be less opportunity for misunderstanding if an expression such as free wiring, which deceives nobody, but makes the possible consumer suspicious, were altogether abandoned.

Protection from High Voltage Shocks.

AN interesting report has recently been presented at the Moscow Electrical Congress by P. A. Kevaleff and a committee of the Imperial Russian Technical Society. A very important fact elucidated by the investigations of the committee was the very indifferent quality of many of the insulating rubber gloves supplied for use at central stations. Out of fourteen pairs, obtained from various makers through the Laboratoire Centrale d'Electricité, in Paris, only three pairs were found to afford efficient protection at high voltages. The tests were made at 1,000, 3,000, and 12,000 volts respectively. In view of these results, and considering also that the best gloves gradually lose their insulating qualities—even when not in use—and that they are liable to perforation and mechanical damage during use, the committee recommend that at all central stations employing high voltages it should be made compulsory to keep an adequate supply of insulating gloves of good quality, that they should be tested by experts at intervals of six months, and that the results of the tests should be entered in the books of the station. When the victim of a shock has to be removed from the high voltage cables, the committee condemn the common practice of attempting to short-circuit the cables with a cloth soaked in water, in case of its being impossible to make a metallic connection. Ordinary river water is not a good enough conductor to cause a sufficient increase of current to blow the fuses; but a cloth soaked in a solution of salt or acid, or even in urine, may be employed. In cases where it is impossible to shut off the current, or to establish a short-circuit, it is recommended that a rope or belt should be placed round the body of the victim by the aid of a stick, after which both ends should be taken in one hand and pulled, thus withdrawing the victim.

European Telegraphs and Telephones.

As compared with the traffic of 1892-93, the internal telegrams of Denmark show a decrease in 1902-03, which is attributed to the increasing use of the telephone, conversations by the latter having increased over five times in as many years. The revenue from telegraphs in Sweden has likewise not been very materially enlarged from 1899 to 1902, the date of latest statistics from Berne. No doubt, here again, the extension of telephonic systems has militated against the growth of telegraphic traffic, for there were close upon 52,000 telephones in use in the Government service in 1900 and 61,400 in 1902. While Companies' lines increased from 50,000 km. in 1901 to 58,000 km. in 1902. Conversations were about 149½ millions in the one year and 162½ in the other, an increase of nearly ten per cent. Receipts were 5¾ million francs, and nearly 6¾ millions, respectively, and per instrument, close upon 100 francs. Similarly, in Norway, telegrams are not largely growing in numbers. There were 1,324,869 in 1901, and 1,340,604 in 1902, excluding the foreign traffic, but communications by telephone increased from 1,723,347, in 1901, to 1,920,155, in 1902, the instruments employed being 14,232 and 15,051 in the respective years.

In Germany, also, the results of 1902 show a diminution of 6,304 telegrams on a total of internal and foreign messages combined of over 42,000,000. But the telephonic conversations increased by nearly 65,000,000, the total being over 757,000,000, for which 352,181 instruments were employed, an increase of 46,359. There was a decrease of 42,710 francs for telegrams, and an augmentation of 7,639,008 francs for telephonic rents. The Pneumatic Tube Service, in Berlin, Charlottenburg, Friedenen, Westend, and other parts has a length of 159 km. in all, which, with 68 offices, disposed of 6,000,000 telegrams and nearly 2,000,000 letters or cards.

In Austria, telegrams increased by 4·2 per cent. in 1902, but no comparison is afforded of the rate of growth of telephone lines: the total conversations and messages exchanged in 1902 being 115,000,000, for which 39,562 instruments were used. In Hungary, telegrams numbered 7,750,000 in 1901, and over 8,000,000 in 1902, and, concurrently, telephonic communications increased from 42,750,000 to 49,500,000, passing through 20,090 instruments.

We may mention these numbers do not of course embrace private instruments and communications exchanged thereby. It is of interest to note that there are 80,000 telephones connected with exchanges in London, and 200,000 in greater New York, and the increase yearly is probably as great as on the Continent.

A Striking Tribute.

We have received, amongst a host of other letters, the following from Franz & Co., Electrical Engineers, Leeds:—

"We are in receipt of the January and February issues of *The Electrical Magazine,* ***and are already in your debt after paying the subscription. The application of one idea in the January issue has saved us several pounds, and the probabilities are, that had we not seen the suggestion then, we should have continued in the old way, at an expense that pays for the subscription several times each month."***

You can secure similar advantages by immediately becoming an annual subscriber. Do not fail to post your order without delay.

SPECIAL ARTICLES

The articles under this section being of general interest to electrical men. are not classified under the ordinary sections of the magazine.

THE THEORY OF ALTERNATORS.—III.

By ALFRED HAY, D.Sc., M.I.E.E., etc.

(Continued from page 131).

In few methods can one form so clear and vivid a conception of the nature of the disturbances taking place in a variable magnetic field as in accurate diagrams showing the correct distribution of the lines of induction at consecutive instants. Such diagrams also furnish information regarding the mechanical or dynamical stresses, the nature of which may be easily inferred by remembering that there is a hypothetical tension along the lines, and an equal (hypothetical) pressure at right angles to them.

For this reason, we give, in the accompanying illustrations, a set of magnetic diagrams which show, with a fairly high degree of accuracy, the nature of the changes which take place in the magnetic field of the solenoid during the rotation of the loaded armature. The direction of rotation is supposed to be counter-clockwise. The undisturbed or *open-circuit field* of the solenoid is a uniform field, and is represented by a series of parallel straight lines, as shown in Fig. 2. This field will actually exist at the particular instant at which there is no current in the armature, and this happens (in the particular case under consideration) when the plane of the armature makes an angle of 45° with the field axis of the solenoid, as in Fig. 2. Let us, however, imagine the coil to be turned so that its axis coincides with that of the solenoid (or that its plane is normal to the field). The lines which would pass through the coil in this position if it were at rest (with no current flowing through it), would form the *impressed armature field*, while the lines lying outside the coil would form the *primary leakage field*. The ratio of the open-circuit field to the impressed armature field would give the primary or field *leakage coefficient*.

As already explained, the current through the coil in the position Fig. 2 is at its zero value, and we get the undistorted open-circuit field in this particular position. As the rotation of the coil goes on, the current through it gradually increases, reaching a maximum value in the position of the coil corresponding to Fig. 5, when it again makes an angle of 45° with the field. If we were to suppose that the current in the coil is maintained at this maximum value while the field of the solenoid is suddenly destroyed, then we should be left with the field due to the armature current alone, and shown in Fig. 8. This field is the *fictitious armature field* at its maximum value.[*] When superposed on the open-circuit field, it gives the distribution of lines represented

---

[*] The full lines show the magnetic lines to the same scale as those of the open-circuit field of Fig. 2. In order to show the distribution more clearly, intermediate (dotted) lines have been added in Fig. 8.

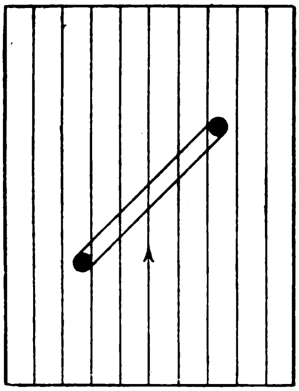


FIG. 2.

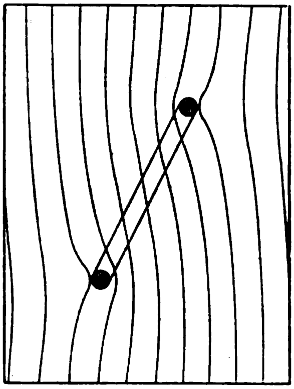


FIG. 3.

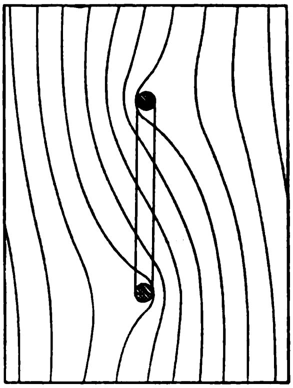


FIG. 4

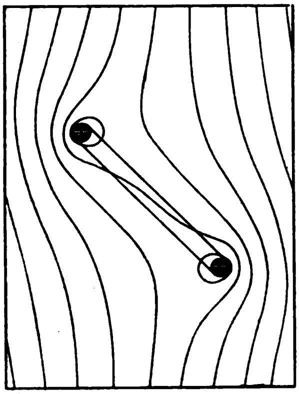


FIG. 5.

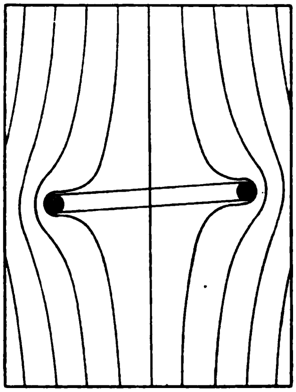


FIG 6.

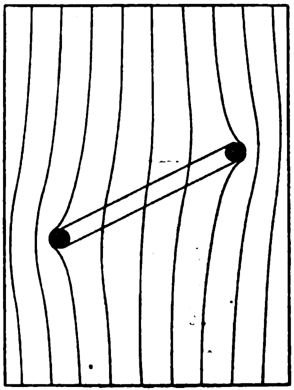


FIG 7.

in Fig. 5. It will be seen that there are lines in the immediate neighbourhood of the coil which are linked with it without being linked with the solenoid; they form little closed paths constituting the *secondary leakage* or *armature leakage field.* There are other lines, however, which are common to both armature and solenoid, and which form the *main field.* Figs. 3 and 4 show the distribution of the lines at stages intermediate between the zero and maximum values of the current while the current is increasing; Fig. 3 corresponding to $\frac{1}{4}$, and Fig. 4 to $\frac{3}{4}$, of the maximum value. The following Figs. 6 and 7, give the distributions corresponding to $\frac{3}{4}$ and $\frac{1}{4}$ respectively of the maximum value of the current while it is decreasing.

The series of changes shown in the diagrams will be repeated during the next half-revolution, completing the cycle corresponding to a whole wave.

An inspection of the diagrams immediately brings out several interesting points. In the first place, it enables us to form a correct conception of the process by which the conductors are made to "cut" magnetic lines or tubes. The field due to the current in the conductor produces a distortion of the solenoid field which consists in a crowding of the lines on the advancing side of the conductor. The moving conductor when conveying a current raises a sort of compression wave in front of it, not unlike the forced wave raised by a steamer as it ploughs its way through water. The distorted part of the line in the immediate neighbourhood of the conductor forms an open loop partly enveloping the conductor. This loop gradually closes in, the isthmus or neck by which it is connected to the line becoming narrower and narrower, until ultimately the loop closes, at the same time splitting off from the line of which it originally formed part, the line

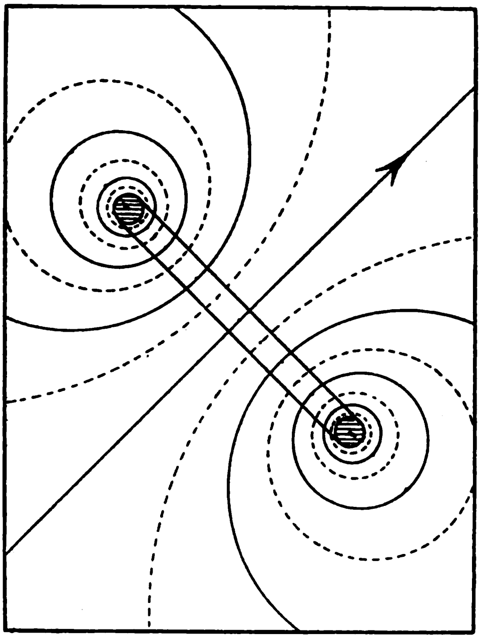


FIG. 8.

itself rebounding from it, and receding to the rear side of the conductor. This process is, for the sake of greater clearness, illustrated in the diagrams of Fig 9. As, therefore, the lines pass from the advancing to the rear side of the conductor, they shed closed loops which become threaded on it. We may think of the closed lines surrounding the conductor as constantly collapsing, and being as constantly reformed by the process just explained.

In the second place, the diagrams clearly indicate that in the positions corresponding to Figs, 3, 4, and 5, the motion of the conductors is being resisted, the resisting torque arising from the distortion of the field brought about by the armature current. In the positions corresponding to Figs. 6 and 7, however, the field distortion gives rise to a *driving torque.* In Fig 2 the resisting torque vanishes because there is no field distortion; and it vanishes again when the plane of the coil becomes normal to the field, because in this position everything is symmetrical, and the forces acting on the two sides of the coil merely tend to squeeze it in, but being in the same straight line give rise to no couple; in Fig. 6, the coil has just moved away from the position of symmetry, and the resisting torque has become negative, *i.e.*, has changed to a driving torque.

The diagrams, therefore, show that the power changes its sign 4 times during each revolution; twice when the current vanishes, and twice when the open-circuit E.M.F. passes through a zero value.

If we suppose that the driving torque exerted by the prime mover is perfectly uniform, and that the combined moment of inertia of the alternator and prime mover is not very large, then it is evident that the angular velocity will fluctuate, and we may regard the actual velocity as consisting of a uniform angular velocity on which are superposed to-and-fro oscillations. Such oscillations or pendular motion may be checked by sufficiently increasing the moment of inertia of the rotating part of the alternator.

(To be continued.)

Alfred Hay

This series has been read with extreme interest, and should be carefully followed. Secure the first two instalments. They are equally as important as the above.

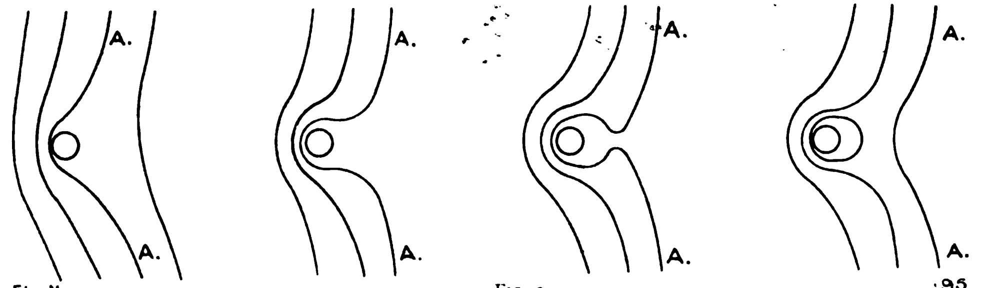


FIG 9

ELECTRICITY APPLIED TO MINING AND METALLURGY.

II.—Electric Draining, Coal Cutting, Drilling, &c.

By PERCY R. ALLEN, A.M.I.C.E.

(*Continued from page 113.*)

The pump for draining the mine, and the ventilating fan for circulating the air may be regarded as being the vital organs of a colliery. If these stop, the whole system rapidly comes to a standstill, and it speaks well for both the confidence of the makers of the plant and the colliery owners, that they are willing to rely on electric transmission for such an important operation. However, when once the reliability of the system was proved, the convenience was obvious.

Electrically driven mine pumps are now built of quite a large size, and at the Dusseldorf Exhibition, the engineering works of Haniel & Lueg, Dusseldorf, exhibited, with the Lahmeyer Co., of Frankfurt, a combination of steam engine and generator in conjunction with a motor and pumps—Haniel & Lueg supplying the steam engine and pumps, and the Lahmeyer Co. the electrical portion, the firm of Haniel & Lueg being the chief contractors for the entire plant. Fig. 1 shows the 750 K.W. 2,000 volt three-phase generator, and Fig. 2, the 650 b.h.p. pump motor. In both cases the dynamo and the motor are keyed directly to the shafts of

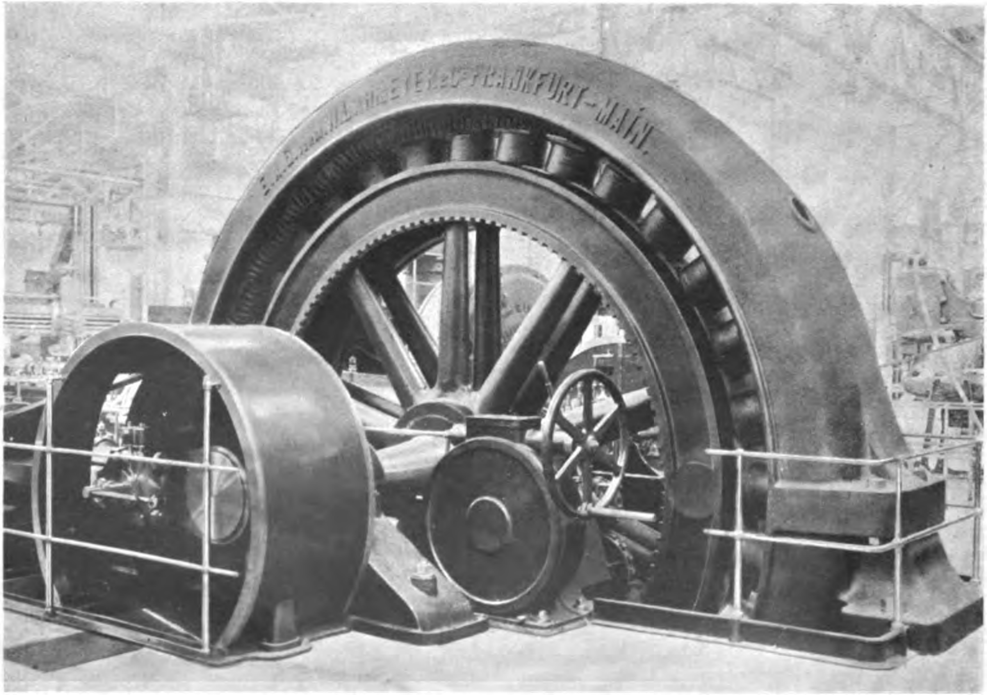


FIG. 1. 750 K.W. THREE-PHASE GENERATOR.

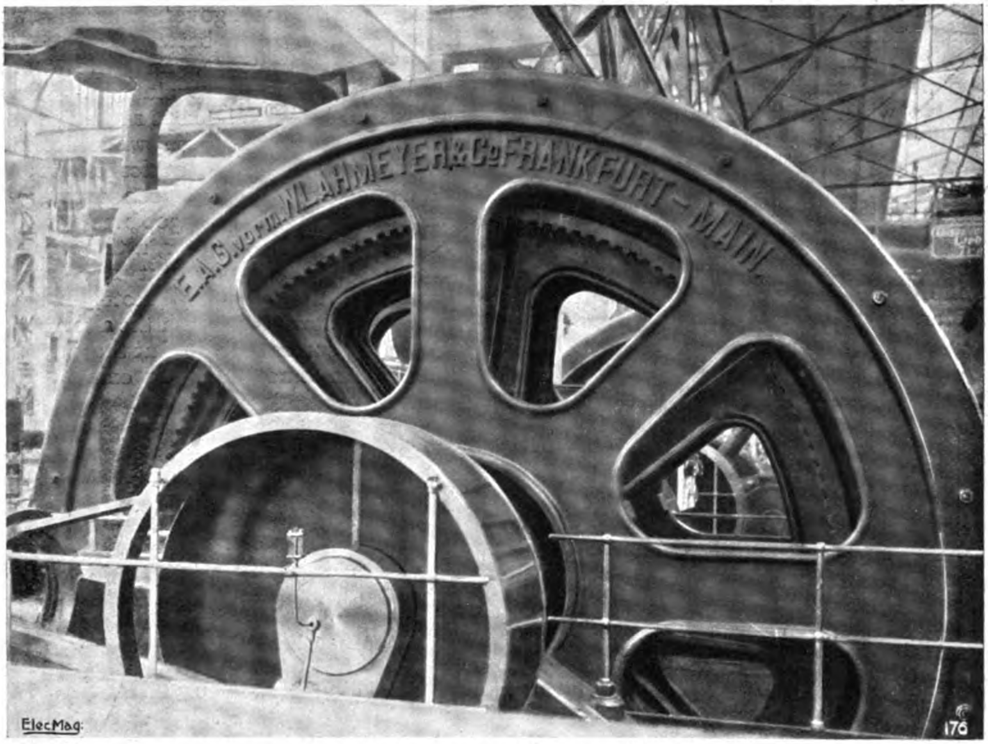


FIG. 2. 650 H.P. THREE-PHASE PUMP MOTOR.

engine and pump respectively. Engine and dynamo are placed above ground, and current is led down the pit by specially insulated conductors of ·12″ × 3·8″ section. The speed of the motor was fixed at 60 revs. per minute in deference to the wishes of the colliery, but in other instances the makers have run as high as 130 r.p.m. using somewhat smaller direct driven pumps. In this particular instance the pump has to lift 1,210 gallons of water per minute against a head of 1,485 feet. The pumping engine consists of two differential pumps, coupled at 90°, on the crank shaft of which the rotor of the motor is arranged. The three-phase motor and the pump start simultaneously with the generator, a patent starting arrangement being used. With this device the column of water in the rising main is used to drive the pump as a hydraulic motor, and as soon as a certain speed is obtained, the signal for switching in is given to the station on the surface. The speed of engine and generator increases up to normal, and that of the pump follows the same. Until full speed is attained the generator is excited by continuous current from accumulators, but on reaching the normal speed, by a rotary continuous current transformer. The motor is of the asynchronous type generally used by the Lahmeyer Co., with certain modifications to give additional security against interruption of service. The rotor has a diameter of about 15′ 4·8″ and is 1′ 5·7″ wide, being made in eight parts to get it down the pit. The stator is 16′ 4·8″ diam., of cast iron in four parts, the overall dimension being 19 ft. The frame is strengthened by a cast iron spider, and both stator and the frame can be disconnected from the feet and turned bodily round on the shaft so as to bring any part up for inspection or repairs. The stator can be adjusted to great nicety relatively to the axis of the rotor by means of wedges and set screws. The total weight of the frame including spider is 33 tons, and of the rotor 27·6 tons.

Fig. 3 shows a motor driven mining pump, by the Berliner Maschinenbau A.G., formerly Schwartzkopff. Where this is installed the water is exceedingly bad, and has a specific gravity of 1·05. The alternating current motor is placed between the two pump cylinders, and develops about 150 h.p. when running 86 r.p.m., and works at 1,000 volts. The pump lifts 176·1 gals. of water per minute 2,017 ft. high. The pump cylinders and valve boxes are of cast steel, and the suction and delivery valve arrangement is interchangeable. The air vessel is kept charged by a small compressor driven by an independent motor.

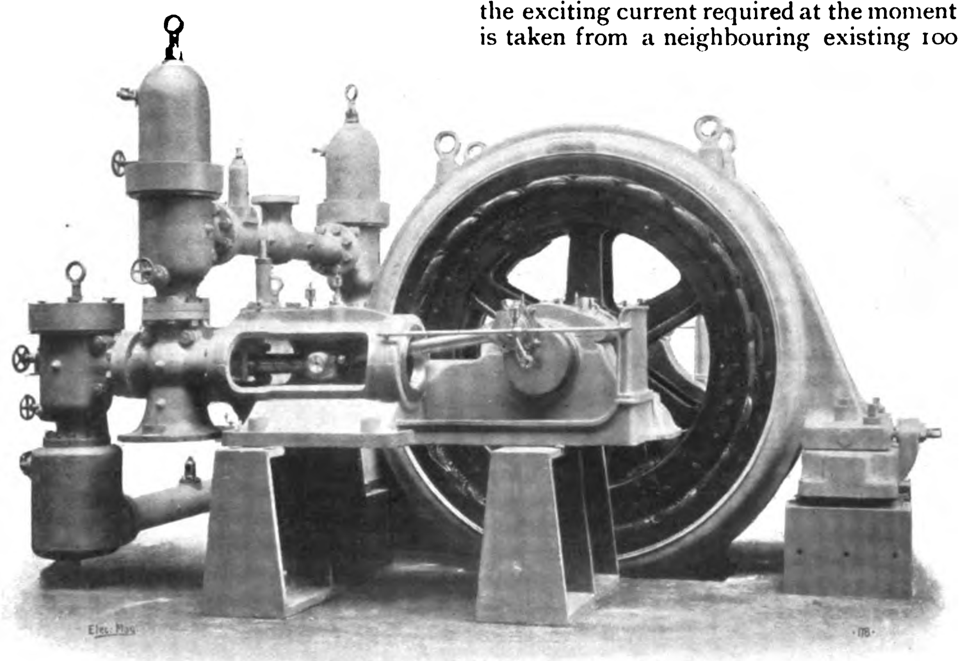


Fig. 3. 150 h.p. Three-Phase Motor and Pumps.

An installation carried out by the firm of Maschinenfabrik Oerlikon, near Zurich, for the drainage at the Monterrad shaft of the Roche la Moliere and Firminy Mining Co., was designed especially, so that no apparatus liable to produce sparking was necessary underground. All circuit breakers and cut outs were placed in the central station above ground (Fig. 4), and the rotor of the three-phase pump motor is internally short circuited. The three-phase alternator is coupled direct to a horizontal single cylinder engine through a flexible coupling on the Zoddel system. The cylinder is fitted with Corliss valve gear, controlled by a Farcot governor having two speeds, one to govern between 50 and 70 revolutions per minute, and the other between 70 and 103 revolutions. This enables the engine to be kept running with economical regulation even when dealing with widely different quantities of water. The engine can be run condensing or atmospheric, and will give 300 b.p.h. at 100 revolutions. The alternator, a three-phase machine, supplies current at 1,000 volts 20 cycles. As the pump motor has to start up simultaneously with the alternator, the exciting current required at the moment is taken from a neighbouring existing 100 volt circuit which can be cut off directly the speed of the exciter rises above 70 revolutions per minute. The conductors from the machines are led to a marble panel switchboard with the necessary instruments and from there an iron armoured three strand cable 328 yards long, extends down the mine to the pumping station, which is in a room at the side of the gallery leading to the main shaft. The pump (Fig. 5) is on the Jandin system and when running at 100 revolutions per minute will deliver 597 galls. of water to a height of 848 ft. The pump has two cylinders and two cranks 120° apart, and is fitted with Jandin patent

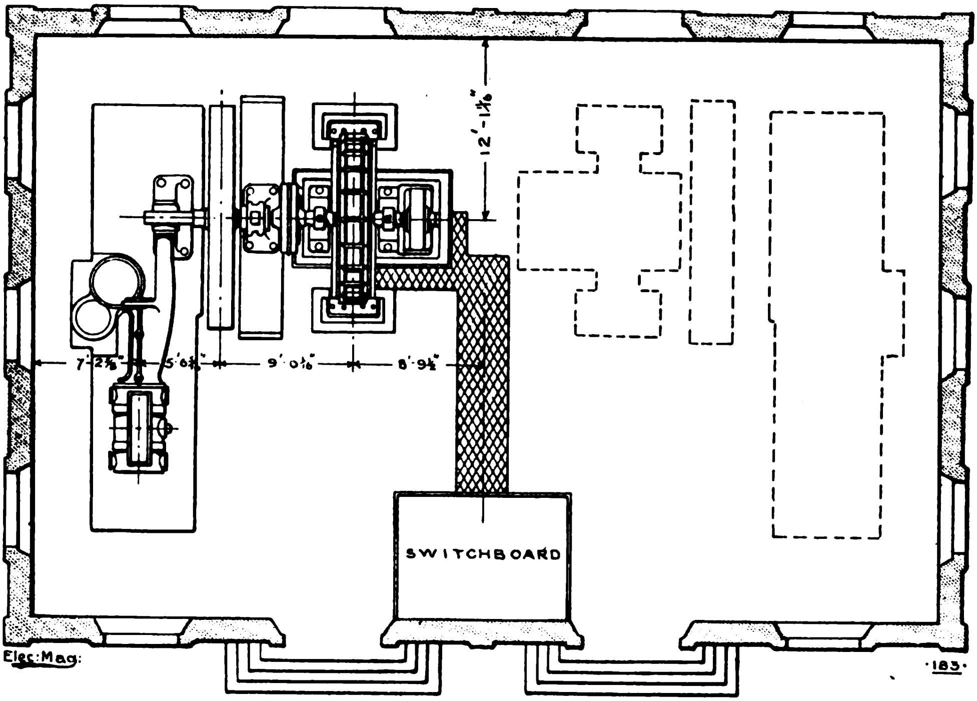


FIG 4 FIRMINY MINING PLANT POWER HOUSE.

valves. A small air pump keeps the delivery air vessel charged. The motor drives the pump through a flexible coupling and takes 200 h.p. when running 100 revolutions per minute, being supplied with current at 970 volts. This stator frame is made in two halves for convenience in getting it into place, as 4·92 tons was the heaviest permissible weight that could be handled. Careful tests showed that the over-all efficiency of the installation was 85·2%, a very favourable record. The plant was started up in September, 1901, and worked for a considerable time without a single stop.

The term express pump is now used on the Continent in a general way as descriptive of any reciprocating pump running at a high piston speed, although the term is usually associated with the large high speed pumps having Professor Riedler's system of mechanically closed suction valves. This system has been adopted by a large number of makers in Germany, and the pumps are very extensively used in mine drainage work. Fig. 6 shows a sectional view of a Riedler express pump made by the Breitfeld-Danek Engineering

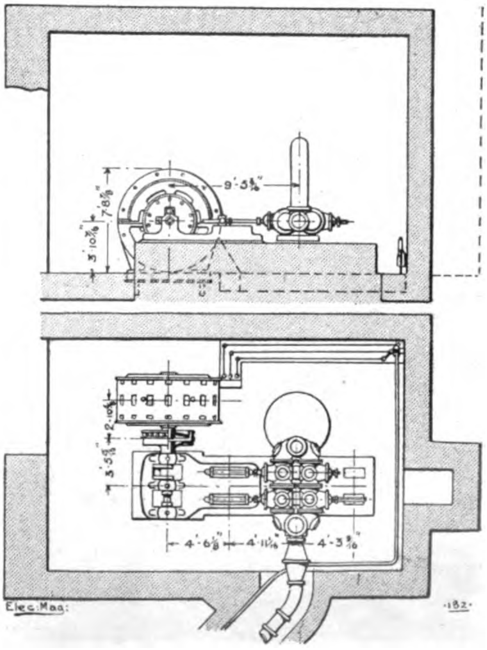


FIG. 5. FIRMINY PUMPING PLANT.

Co., of Prague. The pump runs at the comparatively high speed of 200 revs. per minute. It is capable of lifting 132 galls. of water per minute against a head of 1,312 ft. The elegant simplicity of the valve gear is well shown in the sectional cut. The Riedler pump, with mechanically closed suction valves, has been referred to at some little length, as this type of pump has rendered it possible to dispense with reduction gearing and get a reasonably high rate of speed with the motor coupled direct. However, other means of accomplishing the same end have occupied the attention of inventors, and it has been found possible to very much increase the working speed of ordinary ram pumps by simply fitting individual pipes to each of the suction valves, and making all these dip down into the suction air vessel just below the normal surface of the water. This arrangement brings the water up to each valve without eddies or agitation, and incidentally keeps a much more even air cushion in the suction air vessel than is possible with the usual arrangement. Fig. 7A shows a common suction box, and Fig. 7B one with the separate pipes.

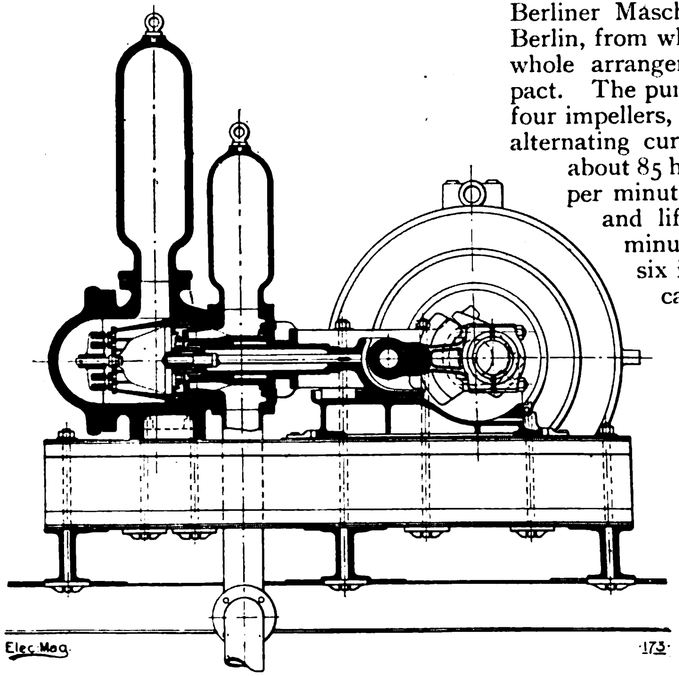


Fig. 6. Section Through Reidler Pump.

The practicability of employing rotary pumps, coupled direct to small motors running at a high speed, in place of reciprocating ram or plunger pumps, is a question that is being much discussed at the present moment on the Continent. These rotary pumps are made with several chambers placed tandem, and are a type between an ordinary centrifugal pump and a form of reverse turbine. Messrs. Sulzer Brothers, of Wintherthur, make them for mining purposes for very high lifts, and in deep shafts several pumps may be placed at different levels, the delivery pipes of the lower pumps forming the suction pipe of the higher one. Fig. 8 shows a chamber pump of this kind made by the Berliner Maschinenbau Schwartzkopff, of Berlin, from which it will be seen that the whole arrangement is wonderfully compact. The pump has four chambers and four impellers, and is coupled direct to an alternating current motor, which develops about 85 h.p. when running 1,335 revs. per minute, working at 2,000 volts, and lifts 440 galls. of water per minute 394 ft. high. By using six impellers, this type of pump can be made to reach 1150 ft. in one lift. For greater heights the Schwartzkopft Co. advise separate pumps placed tandem. The efficiency obtained from this type of pump seems to vary between 70% and 75%. A pair of electric sinking pumps, made by Messrs. Max Schorch & Co., of Rheydt, was shown at the Dusseldorf Exhibition, which had rather an ingenious arrangement for keeping the interior free from water. A drum-like casing was divided into three watertight compartments; a centrifugal pump in the bottom compartment ran at 1,600 revs. per minute, and was capable of shifting 1,320 galls. per minute against a head of 197 ft. The motor was in the top compartment, and was rated at 110 h.p. when working at 220 volts. There were doors in the bottom and middle compartments, which gave access to the pump and commutator, and, as an additional precaution for keeping the interior dry, provision was made for forcing air or gas in under pressure.

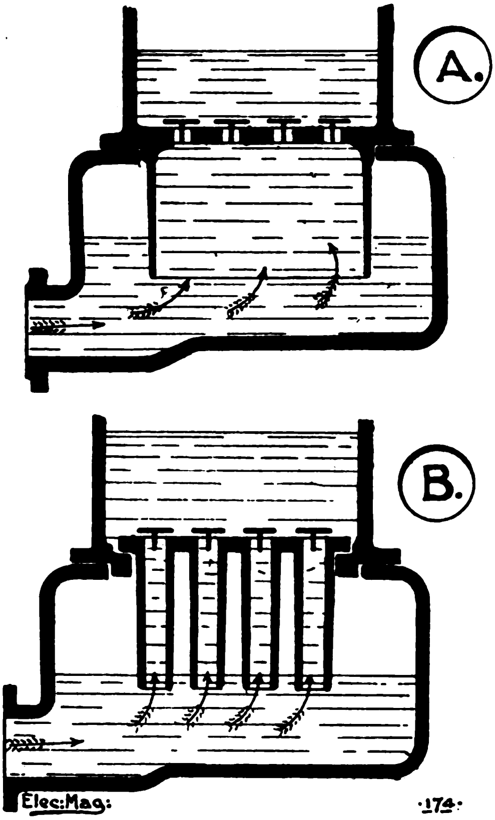


Fig. 7. *(a)* Common Suction Box. *(b)* Suction Box with Separate Pipes.

Remarking on the progress of the large electrically-driven pump, one cannot help observing how very thoroughly the German designers have studied the problem of adapting the pump to meet the conditions of the electric motor.

During the last decade the efficiency of large pumps has been enormously increased, mainly through the scientific reasonings of Professor Riedler, Stumpff, and other mathematicians, and it is rather characteristic of Continental methods that the advice of the man of theory is so eagerly sought after, and so readily followed by the designer and technical adviser in the workshop. Before leaving the question of mine drainage pumps, the writer would like to refer to a question that has often been put to him by mine managers, *viz.*, What happens to the electric motors if the pump and motors get flooded out? The answer is, With a suitably designed three-phase motor very little damage is done, and the pump can probably be got running again nearly as soon as it could with a steam pump. The International Electrical Co., of Liege, who have done a good deal of three-phase mining work on the Continent, a little while back had a very interesting test made by Professors Eric Gerard and De Bast, of the Liege University. A small three-phase motor was completely immersed in water and run for a quarter of an hour. It was then stopped, and remained submerged for twenty-four hours, being placed under seals. At the end of this time, the expert commission again met, and the motor was run for a few minutes. It was removed from the water again, put under seals, and left to dry for another twenty-four hours. After this the insulation was tested, and found to be in perfect working order.

The Guibal fan, or whatever the type of fan employed may be, may be regarded as the lungs of the pit. In some cases it has a fairly steady amount of work to do, in others it has to respond to the variations of the barometer, and possibly, sudden appearances of fire damp, added to which the gradual increase in the working area of the mine demands a corresponding increase in the capacity of the ventilating arrangements. Altogether there are some serious difficulties in deciding on the best. Messrs. Siemens & Halske, who have done a good

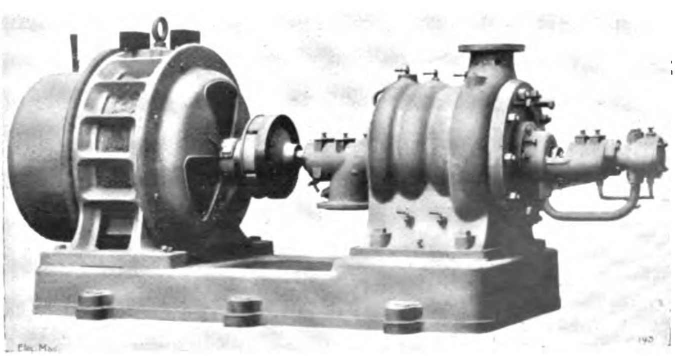


Fig. 8. Electric Rotary Pump.

deal in this direction in Germany, have evolved several methods of meeting the conditions. In one case at the Glückauf mine at Sandershausen (Fig. 9), the fan is belted to a 100 h.p. 500 volt three phase motor. Extension of the mine in this case can be readily met, by changing the diameter of the pulleys, or by the employment of cone pulleys. In other instances, Messrs. Siemens arrange the fan in the first instance to be large enough to deal with the maximum amount of work likely to be required, and regulate by throttling the air supply. This though apparently not very economical in practice, is more so than regulating by the introduction of resistances in the motor circuit. A very compact combination of fan and electric motor has been obtained by using a comparatively short thick shaft, running in a couple of substantial bearings, and having the revolving portion of the motor overhanging on one end, and the wings of the fan on the other end. A machine of this kind with a 200 h.p. motor is at work at the Gabriel Mines at Karwin, Austria.

Besides using electricity to drive the main ventilators, it may with great convenience be applied to working small portable fans or ventilators, which can be moved about the workings and used locally for clearing the faces after shot firing, in fact, wherever the leads run, the motor can be plugged in circuit, and where rock drills are employed they can be worked off a rock drill motor. It is interesting to note in the Glückauf installation, that the fan is in the same building as the electric power station, and in close proximity to the boiler, but even under these conditions it is found preferable to generate current and then work the fan by a motor, instead of coupling on a steam engine direct.

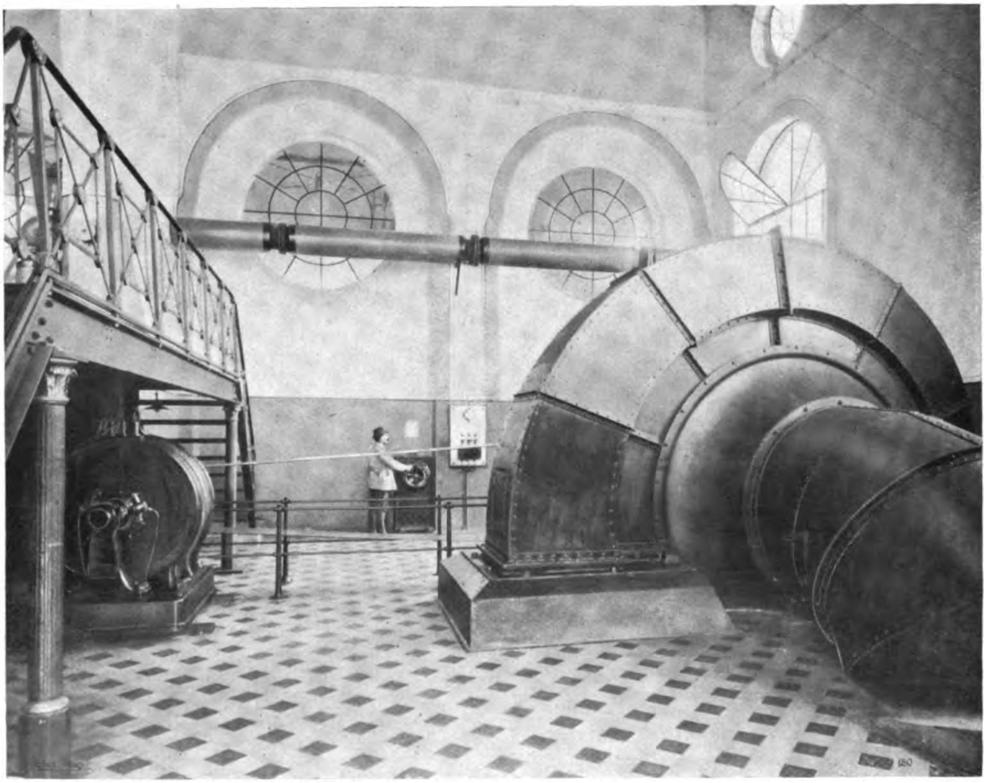


FIG. 9. THREE-PHASE VENTILATING PLANT. GLUCKAUF MINE.

The application of electricity for working drills in mines has been somewhat retarded and rendered difficult by the fact that there was already a formidable competitor in the shape of compressed air transmission, which, in spite of its undoubted wastefulness, had been in general use for at least a generation of miners—indeed, since the days of the boring of the Mont Cenis Tunnel. However, when electricity began to be applied to the other questions of a mine, the working of rock drills naturally came to be considered, and the result of a number of experiments soon proved that from six to ten large drills could be operated for the same amount of power as one compressed air or steam drill, whilst the convenience of manipulation, particularly the ability to withdraw the drill, is much greater than with any compressed air arrangement, and the apparent advantage from the escape of the spent air for ventilating purposes, did not really amount to very much. And so, nowadays, the electrically operated drill is beginning to form part of the regular equipment of any mine worked with electric power transmission.

Electric drills may be broadly divided into two classes: Percussion drills and rotary drills proper. The earliest form of electric percussion drill was modelled on the idea of the electric hammer working with a solenoid, which was shown in public as far back as the Paris Exposition of 1891, and the application to a rock drill was patented by Dr. Werner von Siemens in 1879. This machine had practical disadvantages, as with continuous working the heating became considerable, and, as far as regards power of withdrawing the drill, it was very little better than its compressed air predecessor. At the same time, electricity for rock drills was obviously right, and Siemens and Halske and other inventors soon produced a really workable type of machine. In the modern arrangement, both the percussion and the rotary drills are worked by means of small enclosed motors, which transmit the power to the drill proper by means of a flexible shaft. This allows for all the necessary angular motions, and for the vertical movement of the drill carriage up and down the drill post. A very considerable change of location may be possible by winding the flexible conductors on a portable wheel.

The choice of employment of the two systems depends upon the general method of working the mine, the nature of the material and average depth of holes wanted.

The following table, reproduced from Messrs. Siemens Bros. pamphlet, "Electricity in Mines" give some interesting comparative results obtained in Germany with hand, pneumatic, and electric drills:

	Work done in Bore Hole.				Consumption of energy in Generator. Distance between Generator and Motor being 1 to 2 km. = 1,100 to 2,200 yds.			Total efficiency of the installation.
	In cub. ins. per min.	In cu. cm. per min.	In ft. lb. per min.	In kg-m per sec.	In H.P.	In ft. lb. per min.	In kg-m per sec.	
1. Rotary drills in material of the hardness of rock salt:—								
a. With hand drills...	4·9	80	2,592	6	...	...	...	...
b. With electric rotary drill of Messrs. Siemens & Halske	36·6	600	19,440	45	1·7	54,000	125	36%
2. Percussion drills in material of the hardness of granite:—								
a. By hand, with hammer and chisel ...	·24	4	1,036	2·4	...	...	...	...
b. With pneumatic drill	2·75	45	11,664	27	10	324,000	750	3·6%
c With electric percussion drill of Messrs. Siemens & Halske	3·0	50	12,960	30	1·7	54,000	125	24%

Coal cutting machines worked by electricity have experienced much the same opposition as has been met with in the case of rock drills, and for the same reasons, many collieries having already spent considerable sums in more or less expensive compressed air installations, which they were reluctant to abandon; and moreover, the management of compressed air plant underground has become well understood by the skilled miner. Nevertheless, in the modern mine, electricity is being introduced to actuate the coal cutter, and it has undoubtedly considerable advantages in first cost of installation, and particularly in the after charges for upkeep and operation. Electric motors may be applied to either bar, chain or disc type of machine. Opinions differ as to the relative advantages of the different systems, and as a matter of fact, the system of working the pit must have a good deal to do with the choice of apparatus. In Fig. 10 is shown a machine built by the Breitfeld - Danek Engineering Co., of Prague, under Seltner's patent. Its chief peculiarity is the employment of two comparatively small sized cutting discs placed at an angle to one another, and driven in opposite directions by a bevel wheel between the two, which is actuated by suitable reduction gearing from the electric motor at the opposite end of the machine. The cutting head can be fed in and out by the rack and pinion motion as can be seen from the illustration. The electric motor can be readily dismantled to facilitate moving the machine about. The particular advantages claimed are the small weight of the machine, which is only 2,000 to 2,200 lbs., including electric motors: the small power required, 7 h.p., and the comparatively large output for the power, viz., from 140 to 250 cub. feet per hour, according to the nature of the material. Consideration of the various types of coal cutting machines covers a wide ground, but the main electrical conditions to be complied with are that the motor must be powerful for its size and weight, on account of portability; it must be enclosed or otherwise arranged that no sparking can take place, and it must be occasionally capable of taking a heavy overload, due to the cutting apparatus getting jammed in working.

The electric mine locomotive has been left till last, as it may be regarded as belonging partly to the underground service of a mine and partly to the surface equipment. The illustration shown in Fig. 11 brings this forward very clearly, the electric locomotive with a train of cars being shown just as it emerges from the tunnel at the surface. Considerable ingenuity is often displayed in the design of these locomotives, the working conditions generally rendering it necessary that they should run in tunnels having little headway, and very often only an exceedingly narrow gauge can be allowed, 17·7" being one of the standard sizes. The locomotive illustrated is one of a number of types built by the Allgemeine Elektricitats Gesellschaft, Berlin. It has two motors giving together 90 h.p. at 500 volts, the gauge is 2′ 9", and the speed is 5 miles per hour.

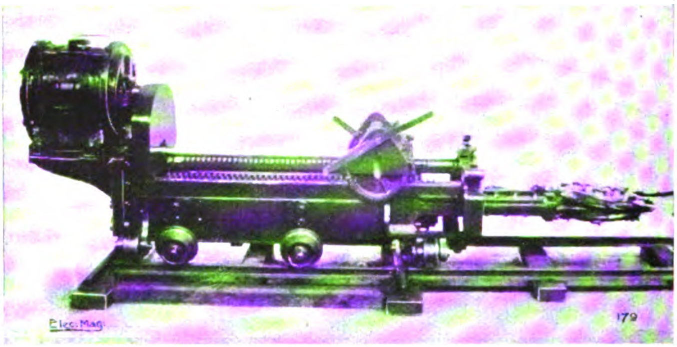


FIG. 10. SPECIAL ELECTRIC COAL CUTTER.

The Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, build mining locomotives in which the power is transmitted directly to the axles by means of worm gearing, the worms being keyed directly on to the motor shaft; this makes a very compact arrangement. Their locomotives of 24 h.p. have a speed of 9·4 miles per hour, and although the normal gauge is 1′ 11·6" for this h.p. they can be run over a gauge of 18 in. A good deal of prejudice exists against worm transmission from an erroneous notion that the friction losses must be high compared with spur gear

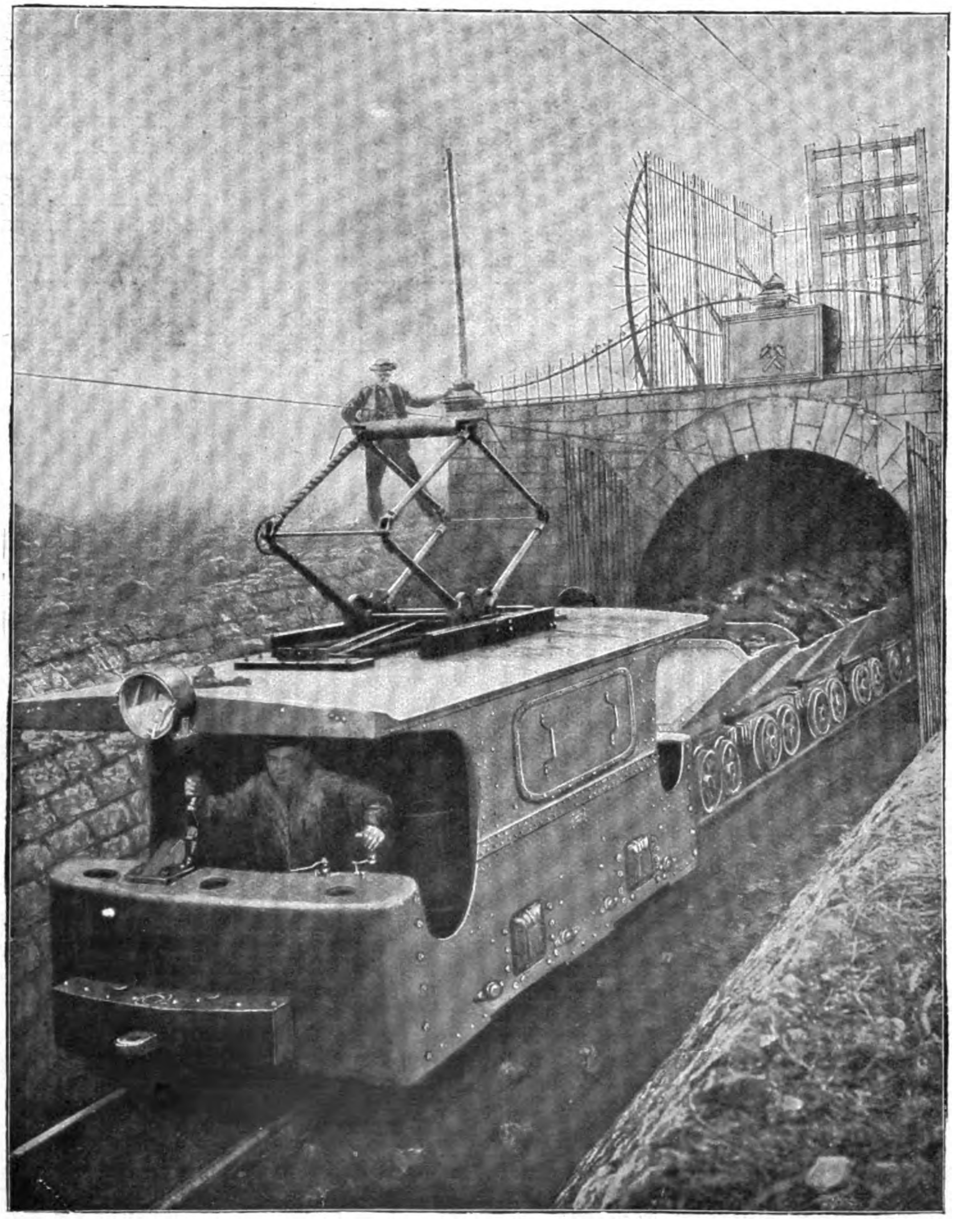


Fig. 11. Electric Locomotive and Cars Emerging from Mine.

transmission; however, the Oerlikon Co. who have given a great deal of attention to the matter have found that by carefully choosing the shape of the tooth and the angle of inclination, and by using tempered steel worms and bronze wheels with ball bearings to take the thrust, it has been possible to attain a very high efficiency, in certain instances even higher than the spur gearing.

The limit of these articles will not permit any description of electric driven machines at the surface works of a mine, although coal picking belts, screening apparatus, and such subsidiary plant are often driven by means of electric machines.

The main point the writer has had in view is to bring out clearly that up to the present moment, electricity is used far more generally in mining operations on the Continent than it is in this country. The main winding engines are driven by electricity, the underground winches, the ventilators, fans, the draining pumps, rock drills, coal cutting machines, the mine locomotives, lighting, signals, etc., all depend on energy generated at a central station. The question of the safety of the leads has been well met by cable makers, and in some mines where the underground workings are very extensive, potentials of 10,000 volts are daily employed.

Where it is necessary to extend the workings of a mine, it is infinitely cheaper and more convenient to fix a set of leads, than a compressed air or hydraulic installation, and long ranges of underground steam pipes are an unmitigated nuisance. Generally speaking the Continental mining engineer feels it advantageous to use electric transmission to a far larger extent than is the practice in Great Britain, and the reasons which have led them to this conclusion are worthy of investigation and study by the electrician and mining engineer in this country. The writer holds no brief for the Continental manufacturer, but to remain in a fool's paradise concerning the progress of one's neighbours is not patriotism, but commercial suicide.

The two following articles will deal with electricity in Continental iron and steel works, where again our Continental competitors have scored heavily, owing to their enterprise in the use of blast furnace gas to generate their current.

(To be continued.)

Percy A Allen

ELECTROMAGNETIC CLUTCHES AND SPEED GEARS.

By RANKIN KENNEDY, C.E.

Electromagnetic clutches are designed to fulfil the same functions as the frictional mechanical clutch, and these functions are three in number:—

1. To stop and start machinery driven from a continuously running engine or shaft.
2. To stop and reverse machinery driven from a continuously running engine or shaft.
3. To vary the speed or reverse machinery driven from a continuously running engine or shaft.

This last is the more important purpose to which the electromagnetic gear applies, inasmuch as two engines of growing popularity and importance, namely, the internal combustion engine and the steam turbine, are not readily reversible in motion, nor easily or economically varied in speed. Hence, when they are engaged in road traction or marine propulsion, where absolute control of speed and direction of motion are imperative necessities, some clutch or other gearing is necessary in both cases.

Some two or three internal combustion engines have been constructed reversible by using two sets of cam levers and a store of compressed air or compressed burnt gases, whereby the engine can be started in either direction as a compressed air engine, and then thrown over to gas or oil. In an internal combustion engine, this, however, leaves the regulation of speed still to be accomplished by gearing. With steam turbine driving the only alternative to gearing is to provide two turbines, one to run ahead and the other to run astern.

It is more with an eye upon these two prime movers that a review of electromagnetic gears is of interest to electrical engineers.

The purely magnetic clutch may be best illustrated by a diagram (Fig. 1) of a clutch invented by the late Mr. Willans of high speed engine fame. The outer iron ring is fixed upon the driving shaft or engine shaft, the inner ring is fixed upon the driven shaft, each has an equal number of polar projections, and the inner one has exciting magnetic coils whereby it may be magnetised to any extent from zero to full saturation by means of an electric regulating switch. When there is no current on the outer driving ring it revolves freely without any effect on the inner ring.

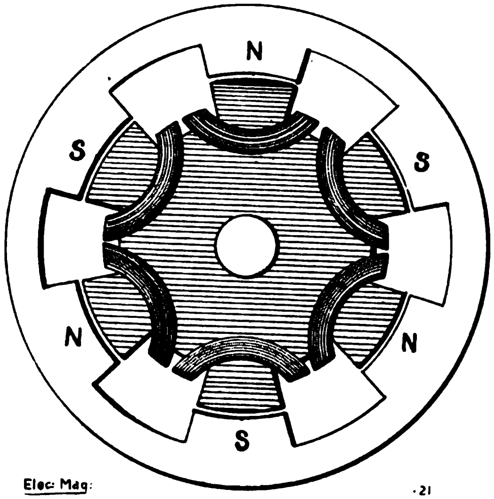


Fig. 1.

but immediately current is turned on, the polar projections drag and a torque is produced depending upon the current strength: finally, at full speed, the poles face each other with the outer poles slightly in advance of the inner driven poles. This clutch is not capable of transmitting much torque, it slips readily and requires close fitting.

The next development in this direction is one found in Patent 21,524 (1898). In this clutch the dynamo electric principle is developed—the inner magnet is driven and carries exciting coils. The description given in the specification is as follows, and refers to Figs. 2 and 3. Fig. 2 is a longitudinal section of a clutch constructed according to this invention, and Fig. 3 is an end view of the same. This clutch consists essentially of adapting an alternating current generator having a short circuited armature and a separately excited field magnet, for the purpose of connecting and disconnecting a continuously rotating shaft and a driven shaft or pulley, hereinafter described with reference to a pulley. The drawing shows the major portion of the clutch, *viz.*: the field magnet A mounted on a continuously rotating shaft B, and motion is to be transmitted to a pulley C mounted loosely on the shaft B. The field magnet A is made up of pole pieces D, D1 and a field magnet coil E, and the latter is connected to an insulated ring F which receives an electric current from a brush G and generator H, the other end of the coil E being connected to the shaft B and thus back to the generator H by way of a rheostat J. The pole pieces D are all of one polarity such as "south," and the pole pieces D1 are all of the opposite polarity such as "north." The pulley C carries a disc K, and on the periphery of the said disc an armature is carried which is composed of a copper or other suitable hoop L and a soft iron or other ring M.

When no current is supplied to the field magnet A, the pulley C stands at rest, but on passing current through the coil E, currents are induced in the armature circuits, and these interlock with the field magnet A, and produce a torque or holding force, tending to prevent the exterior of the field magnet A from travelling at a higher speed than that of the interior of the armature L, and the pulley C is thus driven at a certain speed less than that of the field magnet A, the difference being dependent upon the strength of the field magnet A and the load on the pulley C. The speed of the field magnet A must always differ from speed of the armature L, as the currents induced in the latter depend upon the difference of speed between the armature L and the field magnet A. The strength of the field magnet A may, however, be varied as desired, by varying the strength of the exciting current by means of the rheostat J, thus enabling the strength of the torque to be varied at will to suit the load, which can thus be started gradually and without shock. This clutch gives an enormous torque which depends upon the current in the magnet coils, and its action is smooth and regular. It, however, tends to slip when suddenly overloaded, owing to the lag of the induced currents in the copper ring behind the magnetism, and if it once slips, the driver runs away and the driven shaft comes to rest, no matter how much the field is excited.

An improvement upon this clutch is shown in Fig. 4, in diagram; here the armature is a laminated coil A, with short circuited coils F F; the magnet N S is on the driven shaft, and the armature on the driver. In this form, very large currents are generated in the armature coils at very small slip, and,

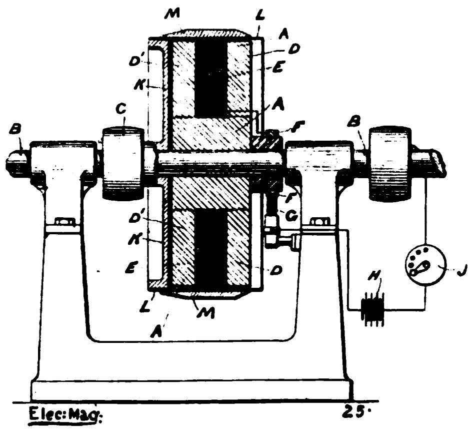


Fig. 2.

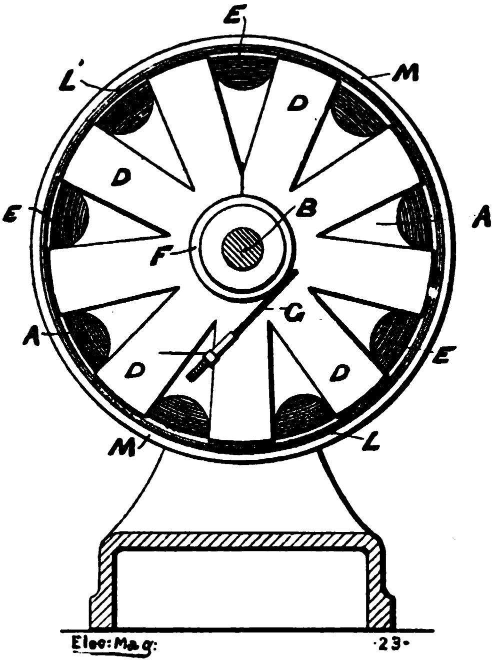


FIG. 3.

therefore, great torque can be obtained by exciting N S fully. And the more the slip the more the torque, for the current in the coils F F is directly proportioned to the slip.

Fig. 5 illustrates Sayer's clutch. Here a pulley carries an exciting coil in a recess, and the pulley is loose on the shaft. The coil can be excited by brushes, B B, from a supply circuit; a disc armature A is keyed to the shaft. Upon exciting the coil the pulley is gripped by the armature and driven by friction. At the start it may be allowed to slip, but at full load there is no slip, but at overload it will again slip.

In these examples, the control of speed is only perfectly given by the clutch shown in Fig. 4, and to some extent, also in Figs. 2 and 3. Those shown in Fig. 1 and 5 are merely for starting and stopping purposes.

In all of them there is no provision for reversing nor for speed reduction, and they require some source of electric current to excite them. By speed reduction is meant driving a slow speed shaft by a high speed shaft, so that the reduction of speed is proportioned to the increase of torque.

For instance, if we employ a steam turbine as a marine engine, we may have an engine speed of 10,000 revolutions per minute to deal with, while we might have a propeller only fit for 1,000 revolutions per minute. In this case, not only is a gear required to reduce the speed, but one also capable of reversing, slowing down, or accelerating the motion.

The only satisfactory electrical solution of this problem is to drive a small high speed dynamo by the turbine, at 10,000 revolutions per minute, and from this through a controller operate an electric motor on the propellor shaft at a full speed of 1,000 revolutions per minute. By means of this combination, a vessel can be as easily and certainly controlled as a tramcar run by electricity; and it is not necessary to have two distinct machines. The high speed armature and the slow speed armature may be combined in one field magnet, thus economising space and expense.

The controller may be placed on the bridge of the vessel, whereby the officer of the watch can control the propellor without reference to the engine room, and there may be a controller also in the engine room.

This system has been attempted on road vehicles in London under the name of "Petro-electric" propulsion. The petrol engine is naturally neither reversible nor variable in speed. Both these operations are provided for in motor cars by complicated, and to most engineers repulsive looking devices. A dynamo on the engine and motors on the car axle are substitutes for these devices which give all the control desired in transmitting the power, but dynamos and motors on a road vehicle, unless very carefully designed with sufficient electrical knowledge and skill, introduce difficulties peculiar to themselves. Standard makes of dynamos and motors designed for stationary purposes are not suitable for the work, and if this system is to succeed on road vehicles a very different design of electrical machinery must be adopted to any yet tried.

In a ship, the case is different, the machines work much under the same conditions as stationary dynamos and motors on land.

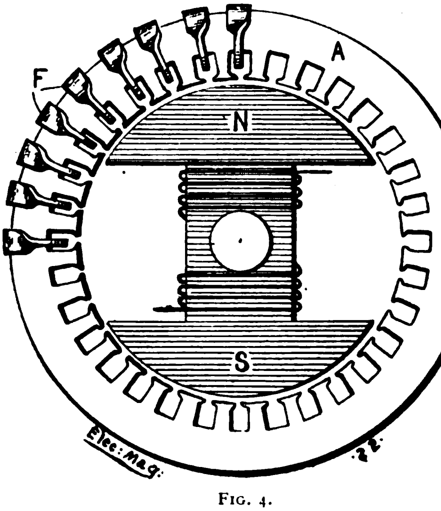


FIG. 4.

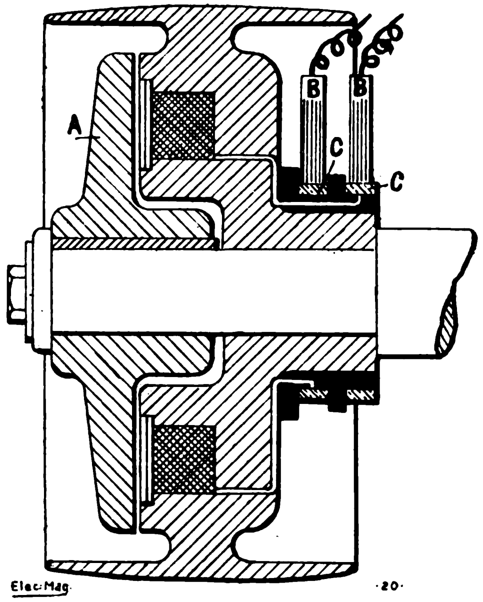


FIG. 5.

and hence, there is every prospect of this electric transmission system becoming of some importance in driving vessels by oil engines or steam turbines.

This electromagnetic combination shown in Fig. 6, acts merely as a connecting link between the oil engine or steam turbine and the propellor, whether that propellor is an axle and wheel on a road vehicle or a screw propellor on a vessel matters not for our present purposes.

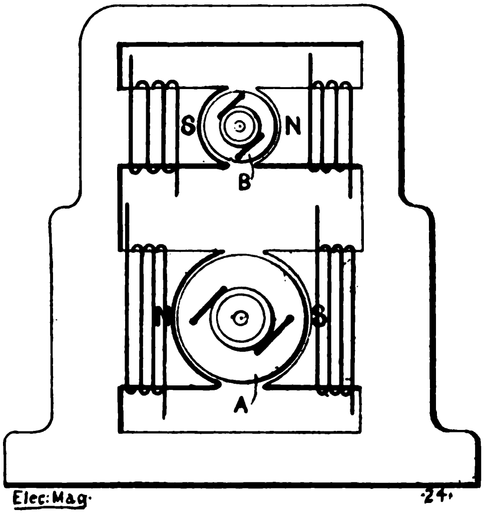


FIG. 6.

In the figure, the armature A is the slow speed one used in the propulsion, its rate of speed and direction of rotation can be controlled as any motor can, by switch gear.

The armature B is the generator armature driven by the irreversible constant speed engine.

The figure is merely a diagram, and intended to convey the principles of construction. Many modifications can be made for the same purpose.

The subject is one which promises to lead to important results, and this brief review of the inventions connected with it, embraces about the whole of the advances made along this line of progress.

Rankin Kennedy

PLAIN OR TOOTHED ARMATURE CORES, Which?

By FRED. W. DAVIES.

In designing a dynamo or continuous current motor, the question whether the armature core shall be plain or toothed (slotted, it is often called) is a vital one, for the general proportions of the machine are to a great extent determined by the answer given to it. Therefore it may be not out of place to systematically catalogue the distinctive qualities of the two classes of armature core; notwithstanding that this will involve a recapitulation of some elementary and well-known facts. To do so will permit a comparison of the two classes of core to be made, with a view to ascertaining under what conditions each will give the best results. The ironclad, or perforated core need not be considered in this connection; for its use is practically restricted to alternate-current machines, on account of the high self-induction of coils wound on such a core, and also owing to the greater difficulty there is of winding the same. Among designers of continuous current machines, there was, until recently, a practical unanimity of opinion in favour of the plain core, owing to a belief that good commutation could not be obtained with the toothed core. Of late years, however, the causes of sparking at the brushes have been investigated, and are better understood, with the result that the toothed core is becoming increasingly popular.

The history of the inception of the toothed core, and its subsequent introduction into recognised practice, is both interesting and instructive. As a matter of fact, the toothed core was the first in the field, for the simple shuttle armature wound with a single coil, which was invented by Dr. Werner Siemens in 1856, was really an embryo toothed drum armature. But when the first dynamos were constructed, it was found that the current fluctuated badly. Pacinotti, therefore, to remedy this defect, introduced (in the year 1864) a cast-iron toothed ring armature having sixteen teeth. This was succeeded, however, in 1879 by the plain ring or Gramme armature, which for a time served a useful purpose. Probably on account of the sparking troubles which were doubtlessly encountered, the idea of providing an armature with teeth appears to have been practically discarded—for a time. It would seem that the advantage this method of construction offered in permitting a reduction of the length of the air-gaps—to say nothing of the other points in its favour—was not at that time fully appreciated. Certain it is, that the advantages known now to accrue from the use of toothed cores were not known at that time.

Early armature cores of the plain ring type were constructed of iron wire; whilst the first form of toothed core consisted of an iron-casting—a most inefficient construction, and one which was not likely to show the toothed core to advantage. Later on, the practice at present in vogue of constructing the core of soft iron or steel stampings was adopted. Owing, possibly, to this, the toothed core has come more and more into favour with designers: not with leaps and bounds, it is true, for its possibilities and limitations have had to be learned in the dear school of experience, but steadily and surely for all that. In fact, the use of this class of core is one of the distinctive features of modern continuous-current designing.

To get a clear understanding of the relative merits and demerits of the two classes of cores, it is necessary to carefully consider the various ways in which each influences the performance of a machine. The question presents itself from several points of view: that is to say, there are certain demands which must—to a greater or less degree, according to their importance—be complied with in order to produce a satisfactory machine. As these demands to some extent conflict with one another, they cannot all be complied with fully, in practice. What one has to do is to allot to the various points their due importance, and then to design accordingly. These points will now be dealt with in their natural order.

(1) The most salient feature in this inquiry, though not the most important, is the method to be adopted for driving the armature conductors. It is a point that merits careful consideration. To a mechanical engineer, the driving of the conductors on a plain core, especially if of the drum type, must appear wofully defective. In the case of a ring armature there are usually no external drivers, the internal spider being relied upon for driving the conductors. With a drum-wound armature, where the conductors are all spaced round the periphery, it is necessary to provide a number of driving horns, which are usually made of vulcanised fibre. In neither case can the arrangement be said to be one that appeals to anyone conversant with standard mechanical engineering practice. An armature in which the conductors are driven by means of teeth consisting of projections of the iron core itself, which is the case with a toothed core, is immensely superior from a mechanical point of view; and when it is remembered that with such a core most, if not all, of the drag comes on the teeth, and not on the conductors, the advantage of this class of core becomes even more apparent. That the stress is borne by the teeth and not by the conductors, has been experimentally demonstrated. Clearly, in so far as the mechanical side of the question is concerned, the advantage lies with the toothed core; especially in the case of large machines, which are more subject to sudden and abnormal stresses.

(2) Just as the teeth magnetically shield the conductors from the mechanical drag, so they also practically prevent the generation of eddy-currents in them. In fact, with a toothed core the tendency to the generation of eddy-currents in the conductors is to all intents and purposes negligible; and it is therefore practicable to use solid copper for the conductors: whereas, with a plain core, it is necessary to use laminated or stranded bars, so as to reduce the loss by eddy-currents to a minimum.

(3) We come now to the question of the excitation of the field magnet. By using a toothed core, the distance between the pole face and the iron core is reduced; and, as a large percentage of the ampère-turns on the field magnet are required to overcome the reluctance of the air-gaps, an economy in both copper and iron (or steel) may be effected thereby. The saving in material thus effected is of importance; and indeed, this is the most palpable benefit derived

from the use of this class of armature core. But in this, as in other problems encountered in electrical designing, there are conflicting considerations which must be taken into account; and for this reason it is impracticable to reduce the length of air-gaps indefinitely. The principal objection to an indefinite shortening of the air-gap, is that, as the length of the air-gap is reduced, it becomes increasingly difficult to obtain sparkless commutation.

(4) With a view to understanding the relative advantages and disadvantages of the two classes of armature cores in respect of commutation, a brief statement of what takes place in an armature coil whilst the current in it is undergoing reversal will here be given. In every armature, whether drum or ring, each conductor (except when its commutator bars are actually under the brush) carries a certain proportion of the total current. Now since the current circulates in opposite directions in the coils under poles of opposite polarity, it follows that (in order to ensure sparkless running) it is necessary, whilst a coil is passing under the brush, for the current in it to fall to zero, and then to be restarted in the opposite direction—attaining its full working value just at the instant that the coil leaves the brush. Under these conditions the brushes will be sparkless, provided the brush holders are of good design, and the machine free from undue vibration. How to comply with these conditions constitutes the commutation problem.

In what way, if any, will the action described above, be influenced by the class of armature core used? In the first place, the effective reversal of the current in a coil "short-circuited" by a brush, depends upon the strength of the commutating pole-tip. Under ordinary working conditions, the magnetism of this pole-tip is considerably weakened by the cross-magnetising influence of the current in the armature winding. This weakening of the pole-tips must be counteracted by the ampère-turns expended in driving the magnetic flux across the air-gap; and the longer the air-gap, and consequently the greater the number of ampère-turns required for it, the less proportionately will be the reaction of the armature winding on the magnet poles. Hence, a plain armature core, which with normal designing is given a longer air-gap than a toothed core, will—other things being equal—give a better result. By working at a high magnetic induction in the teeth, an equally good result may be obtained with a toothed core; but at the expense of general efficiency, for by so doing the hysteresis and eddy-current losses in the teeth are greatly increased.

(5) The core losses are comparatively small in properly designed machines. Analysis shows them to be made up of the hysteresis loss, and loss caused by eddy-currents. In a toothed core each of these losses may be again separated into two parts:—the losses in the core proper, and the losses in the teeth. The latter losses are quite appreciable, often being equal to the losses in the core proper. On this account, the core losses are usually greater when a toothed core is used. This increased loss acts in two ways: it increases the armature heating, and tends to lower the efficiency of the machine.

(6) One source of loss there is, which is peculiar to the toothed core. It is this:—Owing to the movement of the teeth (which are usually highly saturated) in close proximity to the polar faces, eddy-currents are induced in the latter, resulting in heating and a reduced efficiency. The "lines of force" do not, however, pass entirely through the teeth; but to some extent leak out at the sides of the teeth and pass through the slot, thus forming a magnetic "fringe" on each side of a tooth. Advantage may be taken of this property of "fringing" to reduce the loss due to eddies in the magnet poles; for, by making the slots in the armature sufficiently narrow (so that the induction in them due to fringing is fairly high) the flux in the air-gap becomes approximately uniform, and the generation of eddy-currents is practically avoided.. Experience shows that the width of one slot must not exceed one-and-a-half times the length of one air-gap, if this heating of the pole-pieces is to be avoided. When the slots are made wider than this, it is necessary to laminate the pole-pieces.

(7) Last, but not least, is the commercial aspect of this inquiry. In fact, the commercial aspect of electrical problems becomes of greater importance every day. The stress of present-day competition makes it as imperative, in order to ensure the success of a given design of machine, for it to be cheap in production, as it is for it to be efficient, cool, and sparkless in working. Our immediate inquiry concerns itself with the relative costs of construction of the plain and toothed armature cores, respectively. On a bar-wound armature having a plain core, no matter whether drum or ring, it is necessary, as previously mentioned, to use either laminated or stranded conductors in order to avoid the generation of eddy-currents therein. This slightly increases the cost of construction. Also, owing to there being no such support as is afforded by the teeth in the case of a toothed core for the armature sections whilst they are being assembled on the core, the plain core is usually more difficult to wind. Against all this must be placed the fact that the core itself is more expensive if toothed than if plain, owing to the cost of punching the slots in the stampings; or, if the stampings are assembled before slotting, of milling the slots in the assembled core. If the stampings are obtained ready slotted, it is usually advisable to stock two or more varieties for each size of machine in order to cope with the various windings required. On the other hand, a plain core may be adapted to any winding and any number of sections. Where quick

delivery is a consideration—and it is in most cases—this point is of importance. Summarising briefly, it may be said that, in so far as the actual cost of constructing the *armature only* is concerned, the plain core offers the cheaper construction. It should be remembered, however, that it does not necessarily follow from this that the cost of the whole machine will be less. On the contrary, as will be shown later, the cost of constructing the *whole* machine will in most cases be greater if a plain core be used.

It will be well at this juncture to consider the special uses of the plain and toothed cores respectively; and to discover under what conditions each will give the best results. It must not be assumed that the same class of core will prove to be the best under all circumstances. We have seen that the air-gap may be considerably reduced by using a toothed core. Owing to this reduction in the length of the air-gap, less ampère-turns are required on the field magnet; and, resulting from this, the length of the magnet core itself may be reduced. So that it is possible (one might almost say usual—in modern practice) to cheapen the entire design in this way. Also, as has already been pointed out, an armature with such a core possesses a distinct advantage from the mechanical point of view—to say nothing of the absence of eddy-currents in the conductors. The toothed core, however, does not equal the plain core in its commutation; the core losses are greater; eddy-currents are induced in the magnet poles (though these latter may be rendered inappreciable by appropriate designing); and, in any difference there may be in the costs of construction of the two classes of armature cores, the advantage lies with the plain core. The difficulty there is in obtaining sparkless commutation is, however, the only serious drawback there is to the use of the toothed core; and, in the light of present-day knowledge of the principle of commutation, it is a comparatively simple matter to design a really good machine with either class of armature core.

The foregoing considerations serve to show that, generally speaking, the toothed core is to be preferred. It must not, however, be inferred that this is so in all cases. Theoretical considerations (verified by experience) show that, for a machine of a given output, the length of air-gap should vary inversely as the number of magnet poles, in order to avoid sparking at the brushes. This fact precludes the practicability—when there are but few magnet poles—of reducing the length of air-gap by using a toothed core. In such a case, the length of air-gap that would be used with a plain core, in order to allow room for the winding, is also necessary in order that the machine may run sparklessly; so that, even if a toothed core were used, the length of air-gap would have to be about the same as with a plain core. From this it follows that, for a machine with but few magnet poles, a plain core is more economical; whilst, for a machine having many magnet poles, a toothed core will yield better results. The question remains:—At what point in the change from a two-pole machine upwards ought the change from a plain core to a toothed core to be made? In the opinion of the writer, a plain core should be used for a two-pole machine: for machines with more than two magnet poles the toothed core is to be preferred. This does not apply to very small machines. In these the output is usually limited by heating and not by sparking; and in such cases the toothed core may be used with advantage.

The heating of the pole-pieces by reason of the eddy-currents induced in them by the teeth when the slots are too wide has already been referred to. To avoid this heating and consequent waste of power the plan of making the tooth overhang the slot at the periphery is sometimes resorted to (Fig. 1). This makes the induction in the air-gap more uniform, and is an effective means of minimising the eddy-currents in the pole-pieces. This plan is not always advisable, however, as it necessitates the armature being hand-wound, owing to the impossibility of getting former-wound coils into the slots; and even with hand winding, the winding is difficult. The plan of slightly rounding the edges of the teeth at the periphery—the slots being otherwise of the ordinary proportions—in order to avoid damaging the insulation by the sharp edges of the teeth (Fig. 2) carries with it also the incidental advantage of rendering the magnetism of the teeth less sharply defined, and thus makes the induction in the air-gap more uniform. It has the same result, magnetically, as making the teeth overhang the slots, though it is perhaps not so effective.

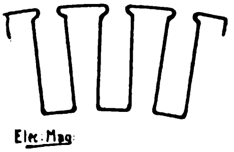


Fig. 1.

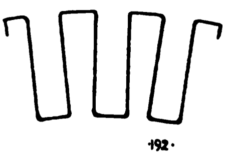


Fig. 2.

The question of the class (plain or toothed) of the armature core to be used in a given machine, is important, and one, moreover, that does not always receive the consideration it should do; and if this article has—in a small measure, perhaps—served to direct more attention to the points touched upon, its purpose will have been served.

Fred. W Davies.

POWER: and its application to INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

Water Power in the British Isles.

By W. E. WARRILOW, A.M.I.E.E.

ALTHOUGH there are some 2,300 electricity undertakings in this country, but 12 of these are operated by water power, and their aggregate capacity does not exceed 2,000 h.p. British engineers have a natural partiality for steam, and the development of the electrical industry in Great Britain would be incomplete were it not associated with steam and the steam engine. Our national asset is undoubtedly coal, and without this, our steam engineering triumphs would never have been achieved. It is not surprising, then, that we have not displayed the same energy in designing and building turbines to suit the water falls of our country, as we have in perfecting the steam engine. The manufacture of water turbines has not been reduced to a science here. In other countries, abounding in falls constant throughout the year, the construction of such power units has been carried to a high degree of perfection, but this particular type would be quite unsuitable for such falls as are fairly regular in their flow in these islands.

In fact, whatever opportunity of installing hydro-electric plants there may have been, has been wofully neglected, or such plants as have been laid down and proved unsuccessful are looked upon as significant of future failure, without due regard to the design of the apparatus. We are naturally afflicted with low falls, which are seldom constant both as to fall and flow, consequently we do not trouble to probe a seemingly intricate problem. Mr. A. Steiger, M.Inst.C.E., however, in a paper recently presented before the Institution of Civil Engineers, pointed out that these difficulties were more apparent than real, and that, with a properly designed turbine, falls as low as 2 ft. could be made to give up their power. With encouragement from such an authority, there opens up a vista of possibilities as to the conversion of so much energy as is at present undoubtedly running to waste, into a more useful form.

The general spread of electric power plants throughout the country has been marked with the starting of many small steam stations, which can hardly hope for good results when their larger *confrères*, with an improved load factor, have difficulties in making ends meet. The utilisation of a neighbouring river, with suitable machinery available, would materially enhance the prospects of these small fry among power stations, while turning to good account natural power sources which would otherwise remain untapped. With his experience of the work in question, Mr. Steiger should shortly produce evidence that the hopes he now entertains are capable of realization, and in this event we may see many efficient, if small, plants operating throughout the country under conditions distinctly favourable to economy.

The position does not necessarily cast reflections on British makers of water wheels, as these have doubtless done excellent business, but the particular demand has probably never arisen for such a turbine as Mr. Steiger drew attention to. We may yet see a striking development in this direction as the practical outcome of his remarks, and if such becomes the case, turbine makers in this country will not be found slow to avail themselves of the opportunity for business expansion in this quarter.

STEAM TURBINES.

Some Comparisons in Power Houses.

We referred last month in an Editorial Note to the space occupied by steam turbines in the lay-out of a central station, and specially mentioned the size of the boiler house as compared to the engine room. A glance at the accompanying sections through some typical turbine stations will make this comparison more striking. Figs. 1 and 2 illustrate power plants with Westinghouse and Curtis turbines respectively, and in each case the boiler house appears abnormally large compared to the adjoining engine room. In the Chelsea power house of the Underground Electric Railways of London (Fig. 1) the boiler house is 96 ft. 6 in. wide, and the engine room but 72 ft. 6 in., the former containing 80 boilers in two tiers, and the latter 10 horizontal Westinghouse turbines aggregating 55,000 K.W. The boiler house includes coal handling appliances and bunkers. The turbines are neatly arranged on foundations 41 ft. deep, set in two rows, between which are the condensing plants. In Fig. 2, the boilers are arranged on a level, consequently the ground space occupied is greater, and the engine room is exceedingly narrow, in that vertical Curtis turbines are used. The extra width in the engine room is taken up by rotary converters, which would not ordinarily be found in an engine room. The plant illustrated is that projected for the Massachusetts Electric Railways Co., at Quincy Point, near Boston. The aggregate output is fixed at 15,000 h.p. in 5 units. The building is 160 ft. long by 121 ft. wide, and fully half of this width is devoted to the boiler house. The latter will contain ten 750 h.p. water tube boilers arranged in two lines facing each other. In Fig. 3, a power plant employing vertical reciprocating engines is shown, and the proportions of boiler house to engine house are here more evenly maintained. The former has a width of 41 ft. 7 in., and the latter of 36 ft. 3 in. The plant illustrated supplies power to the Rochester & Eastern Rapid Railway, U.S.A., and aggregates 2,100 h.p., a considerable reduction upon those quoted above, but this fact in no way modifies the comparison between the particular class of unit installed. If reciprocating engines of large power are used they necessitate a considerable increase of space in the engine house. In this respect the units depicted in Fig. 4 and 5 are worthy of attention, as affording a striking comparison between turbo-generating plants and those driven by reciprocating engines. Fig. 4 illustrates a 5,000 K.W. unit driven by two vertical and two horizontal engines, placed on each side of the generator. Fig. 5, in turn, depicts a turbo-unit of the same output. Four of these latter sets will occupy less floor space by 6 in. than 2 of the units shown in Fig. 5, even taking into account a space of 9 ft. 6 in. between each turbo set, or 28 ft. 6 in. in all. The reciprocating sets, however, would cover almost every inch of space.

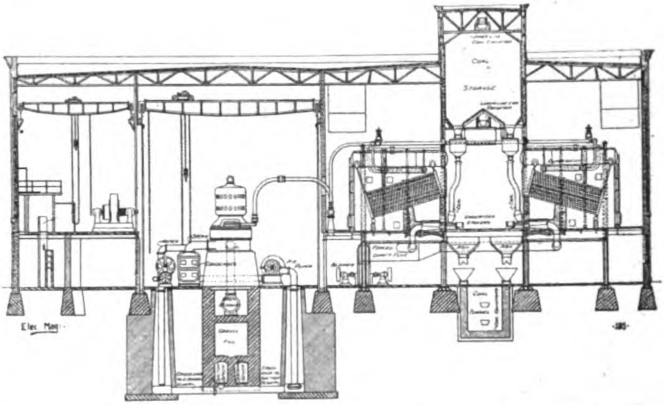


Fig. 2. Quincy Point Power House. Curtis Turbines.

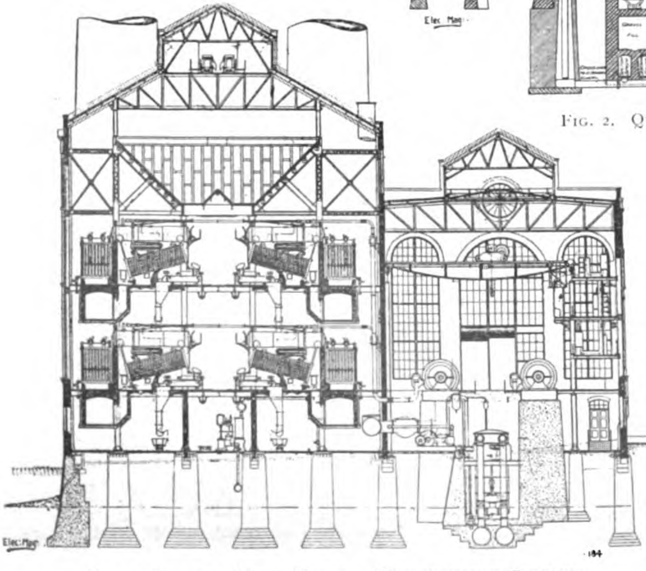


Fig. 1. Chelsea Power House. Westinghouse Turbines.

Now that the floor space of generating units is being so rapidly decreased, engineers will be looking to the steam-producing portion of the station with a view to reducing what will otherwise become a ponderous adjunct to the plant.

Turbines, though economical in floor space, make almost equivalent demands on the boiler house to reciprocating engines, so that such reductions as are made in the latter quarter will need to be on similar lines—same output from plant occupying vastly less space. In the limits of two pages it is not possible to treat such a subject as it deserves; but the power house sections have been chosen chiefly as graphic illustrations of the present trend of events in the design of such stations. The necessity for large units, to which the desire for simplicity may be chiefly traced,

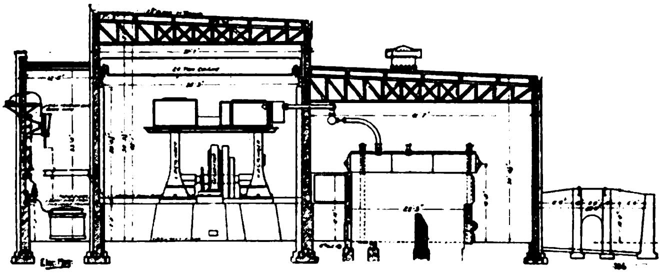


Fig. 3. Rochester U.S.A. Power Plant. Reciprocating Engines.

has certainly compelled makers of reciprocating engines to look to their laurels. In power house design, though we were prepared to tolerate reciprocating engines in medium sizes, subsequent developments practically enforce their displacement by the more compact prime movers, in which the velocity and pressure of steam is more directly transformed into mechanical energy. While dealing with this subject we may refer to the work of Prof. Reidler, whose researches, in conjunction with Prof. Stumpf, have been productive of most excellent results. The problem has evidently been approached by him with a view to materially reducing the floor space, not only of the turbine itself, but of its attendant condensing apparatus. Such a move naturally leads to speculation as to the ultimate form a steam driven dynamo will assume, if what has come to be recognised as standard practice in reciprocating plant is to be completely reversed. From particulars recently published in *The Electrical Review* a feature of the Reidler-Stumpf design is the attachment of a centrifugal jet condenser to the turbine shaft itself. Steam enters at the centre of the condenser through an annular channel in the turbine casing from the last moving wheel and mixes with cold water, which also enters at another part of the case. The entire arrangement occupies a small space under the turbine body, in fact, forms part of the main casting.

With generators of this description, having vertical shafts and turbine sandwiched between dynamo and condenser, the space occupied in the station would probably be far less than that of the switchgear, and by the side of many power houses employing reciprocating units would appear almost ludicrous. The subject is, however, one of extreme moment, and immediate steps must either be taken to reduce the size, while retaining the capacity, of boiler house plant, or of modifying the layout of the entire station. Whatever the developments of the future may be, little doubt can be entertained that the present tendency to economise space and simplify the design of steam units will give rise to radical alterations in the design of both large and small power houses. Any scheme which will reduce the first cost of buildings and subsequent maintenance charges upon the same will hasten the day of cheap power, even in a country whose natural resources do not admit of the more direct production of electrical energy. It is not beyond the bounds of possibility that, with modern machine tools, with their extreme accuracy, when applied to the construction of a standard design permitting repeat work, we shall see turbines commercially and universally established in most large power houses in two years. Certainly the design is not fraught with such complications as characterise reciprocating sets, and speedy production is furthered rather than hindered by the principle of the machine. Erection again, though requiring extreme care and accuracy, is facilitated, and previous to installation massive foundations are not required. These items all contribute to the reduction of the time occupied in getting a station erected, equipped, and started up, and nowadays, when the public are alive to the uses of electric power, it is encumbent on supply authorities to take advantage of modern units, the introduction of which will hasten the materialization of their particular schemes.

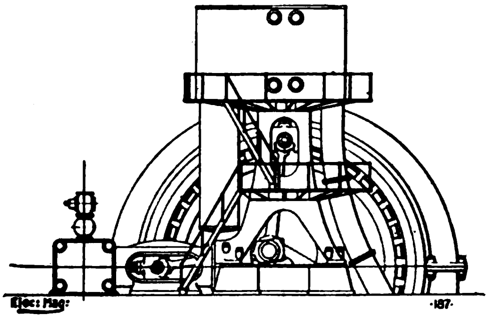


Fig. 4. 5,000 k.w. Reciprocating Unit.

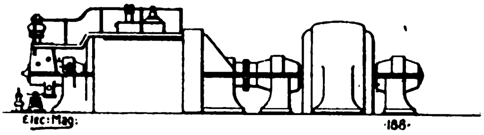


Fig. 5. 5,000 k.w. Turbo Unit.

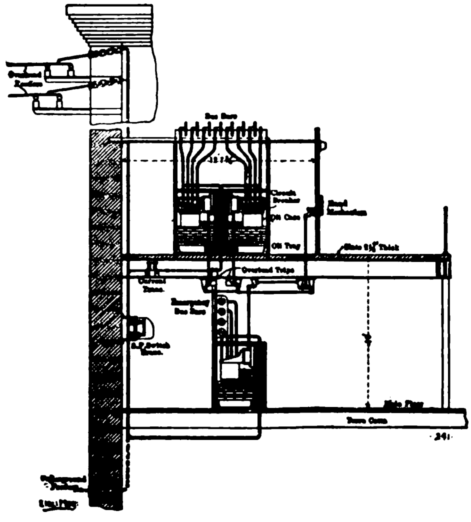
The steam consumption of turbo-generators has received careful consideration at the hands of users of such plant, and for large units it can certainly be favourably compared with reciprocating engines. In smaller powers the latter can easily hold their own, but in monster installations, where mere efficiency is not everything, the turbine comes prominently to the front, as such items as maintenance, attention, and space occupied must receive closer attention with the increased size of plant. On the grounds of compactness the steam turbine will be hard to beat, and its future employment will be watched with the keenest interest in engineering circles.

In our next issue we shall publish a special article on Steam Turbines for generating stations, which will be found of exceptional interest. It will be from the pen of an expert on the subject.

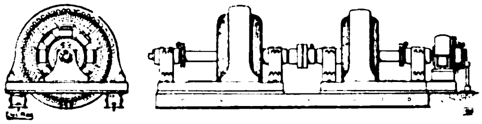
THE MONTREAL POWER SCHEME.

In our last issue we gave a rough outline of the power scheme which has developed in the vicinity of Montreal, and which is the largest centre of transmitted hydro-electric power in the world. We can now furnish further details which will be of interest to our readers. The transformers in the various sub-stations are all of the air blast type, and special electrically driven fans furnish the requisite cooling blast at a pressure of 1·8 inches of water per sq. in. The transformers and their attendant blowers are arranged in the centre of a sub-station, and galleries around the sides accommodate the necessary switching appliances. The high voltage lines are protected with static interrupters, and in each case oil switches, either hand or motor operated, are used. Lightning arresters, giving 264 gaps between each conductor and the ground, are connected to the transmission lines. At the Maisoneuve sub-station, which is at the end of the 85 mile line from Shawinigan Falls, a number of interesting frequency changers are used. These are illustrated herewith, and it will be seen that they comprise a motor (on the left), a generator, and an exciter. The latter is used as a motor for running the combination up to speed. The 30 cycle two-phase current generated at Shawinigan is transformed there to three-phase 55,000 volts, transmitted by aluminium cable conductors to Maisoneuve, where a reduction to 2,300 volts takes place. By the frequency changers this is altered to three-phase 60 cycle current at 2,300 volts. The sets are rated at 1,068 kw. 100 per cent. p.f., and 800 kw. 75 per cent. p.f., the speed being 450 revs. The machines are run in parallel, but to avoid cross currents a proper adjustment of the field currents must be made before they are switched in.

The transmission line from Chambly to Queen Street, Montreal, encounters several obstacles, which have been surmounted in a manner worthy so great an enterprise. The Chambly Canal is crossed at a point where four steel towers were necessary to support the lines. Each tower, designed to carry twelve No. 2/0 bare copper wires (diameter increased to 1 in. by ice), is 144 ft. high, and contains nearly 14 tons of steel. Each tower is provided with a ladder, and supports three sets of cross arms in one horizontal plane. One set rests on the top, the next is 30 in. below, and the third 30 in. below the second, on the tower. The lines also cross the Richelieu River just below the power house, and the four three-phase lines are carried across in six 125 ft. spans. Six concrete piers are erected in the river, each supporting two poles, which in turn carry two cross arms each for supporting the lines.



4,000 VOLT SWITCHBOARD AND LINE.



FREQUENCY CHANGER.

The Lachine Rapids plant possesses many features of interest, not the least of which is the low fall (16 ft.) at which the turbines operate. Single vertical turbines, with a long horizontal shaft, are used; these shafts being connected by gearing to the vertical shaft of six turbine wheels. The turbines and generators are arranged in three groups, the power house being 1,000 ft. long. The original frequency of 60 cycles has been raised to 63 by a slight increase of speed, so that the plant can operate in multiple with the Chambly machines, whose frequency had been lowered from 66 for a similar reason. The total plant capacity at Lachine is now 6,000 K.W.

On December 1st, 1902, a portion of the dam at Chambly broke loose and permitted the escape of a large quantity of water; in fact, the plant could not be operated at its full capacity. The damage has only recently been repaired; but the detached portion still stands—a monument to its builders—in midstream, bristling with the iron rods intended to hold it. In the power house two sets of bus bars are provided for the two-phase 2,200 volts current from the generators. Selector switches, hand operated, are used to couple any of the eight generators with either of these bars. The machine switches proper are of the motor operated oil type in brick chambers. The turbines comprise four McCormic wheels, mounted together, for driving each unit, and operating under a head of 31 ft. at 152 r.p.m. Each generator is rated at 2,200 K.W., and four of the eight are General Electric machines, the remaining four being Stanley machines, while the total output is 16,800 K.W. The engine room is 277 ft. long by 28 ft. wide. The water wheel chambers are surmounted by a cable tunnel 6 ft. by 6 ft. 6 in., and above this the switchboards are built. A special construction of steel trusses and girders provides a track for the overhead electric travelling crane.

The entire scheme is a monument to the efforts of electricians and engineers, to financiers and organizers in building up a corporate system of many scattered plants. Subsequent developments on the St. Lawrence should be productive of equally striking results.

VARIABLE SPEED CONTROL OF MACHINE TOOLS.

THE selection of the best system of electric driving must be governed rather by the reduction of the labour bill than by economies produced in the coal item of the power plant. The variable voltage system admits of a fixed voltage at the generator terminals and three unvarying voltages of unequal value, maintained between the wires of a four-wire circuit, various connections of which offer six different and distinct voltages. The principle of the system, which is the development of the Crocker-Wheeler Co., is that in a separately excited shunt motor the armature speed is proportional to the voltage supplied to its terminals. Constant voltage will maintain this speed constant even with varying loads. By the use of a three-unit balancer these voltages are maintained constant, and out-of-balance currents are accommodated. A drum controller connects the motors (for variable speeds) to the six circuits of the system, giving six different speeds, each of which can be varied by altering the motor's field strength. Arcing is avoided at the terminals by special quick breaks. A speed range of 6:1 can be secured on the voltage points alone, while with the field adjustment this can be extended to 10:1. Motors are classed under four heads: A, constant speed, such as for driving shafting; B, controllable speed, series wound, as on cranes; C and D, controllable speed, as on individual tools where constant speed at fixed values must be maintained. C covers blowers, presses, planers, etc., demanding constant torque at all speeds. D covers lathes, boring mills, where the torque increases as the speed drops. The accompanying diagram explains clearly the connections of the system. Results have shown that as much as 20% increase over a belt driven tool has been secured with motor drive, and the choice of speeds as indicated above. 2½% increase in output would warrant the outlay on the individual drive, so that the possibility of large saving by the system is at once evident. It is interesting to note that the question, whether electric driving is suitable for machine tools, is hardly ever hazarded, as there is little room now left for doubt as to its superiority. Instead of quibbling over this matter, electricians are developing schemes, of which the above is an outline. Further investigations will, doubtless, occasion the introduction of the most economical and efficient methods as time goes on.

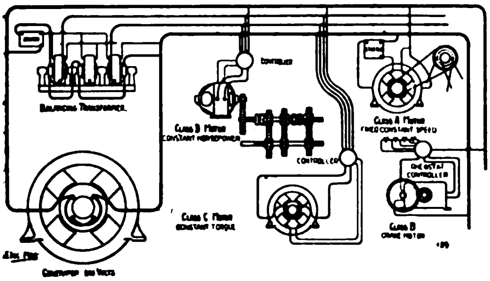
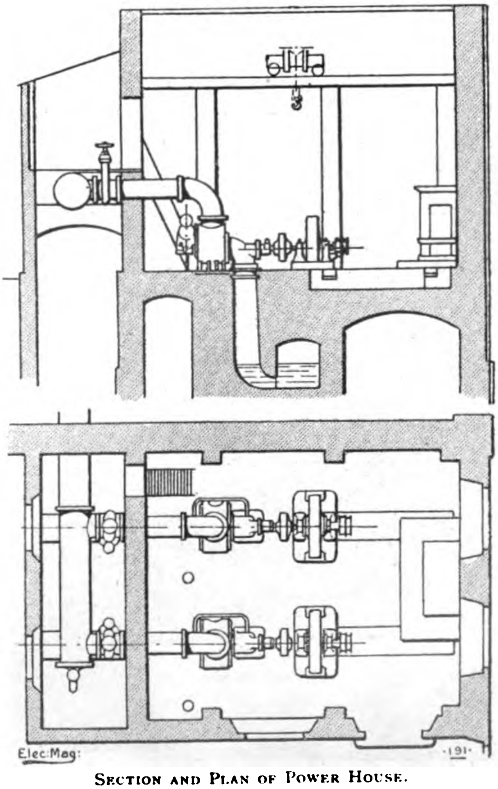


DIAGRAM OF CONNECTIONS.

TUNNEL VENTILATING BY ELECTRIC POWER.

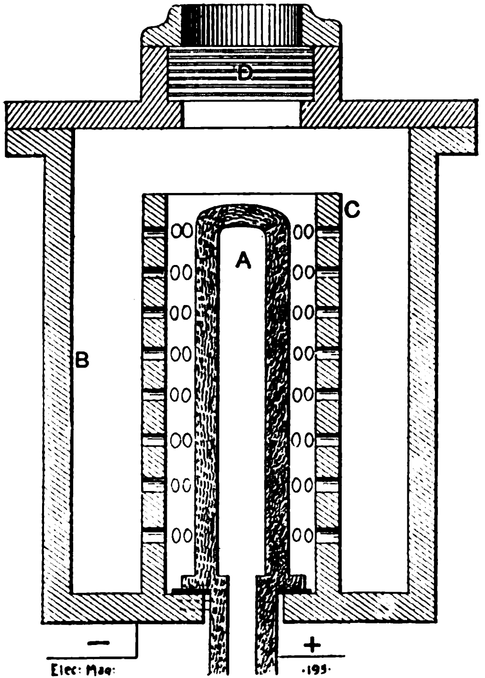
THE ventilation of railway tunnels has long proved a troublesome matter, but here, as in other cases, the services of electric power prove of undoubted value. *The Engineer*, which recently described some typical ventilating installations on the Continent, referred to that of the Mont Cenis Tunnel, where a hydro-electric plant has been installed. The river Melezet supplies two turbines, under a head of 151 ft. 4 in., and at 375 revolutions they furnish 235 h.p., being coupled direct to two three-phase alternators, as shown in the accompanying illustration. Energy is delivered to the ventilator station at 3,700 volts where two three-phase motors of 210 h.p. drive two fans 16 ft. 4 in. diameter by 5 ft. broad. The aggregate horse-power required at the shaft is 345. The tunnel cones or tuyeres are of sheet iron, and the calculated speed for the air driven into the tunnel is two metres per second, the area of the tunnel being 441 sq. ft. We understand from our contemporary that some minor additions will be made to the plant which has recently come into regular operation. The installation is an interesting example of what can be done with the water power available and adjoining a railway system. We are not blessed in this country with such power facilities.



SECTION AND PLAN OF POWER HOUSE.

ELECTRICITY DIRECT FROM FUEL.

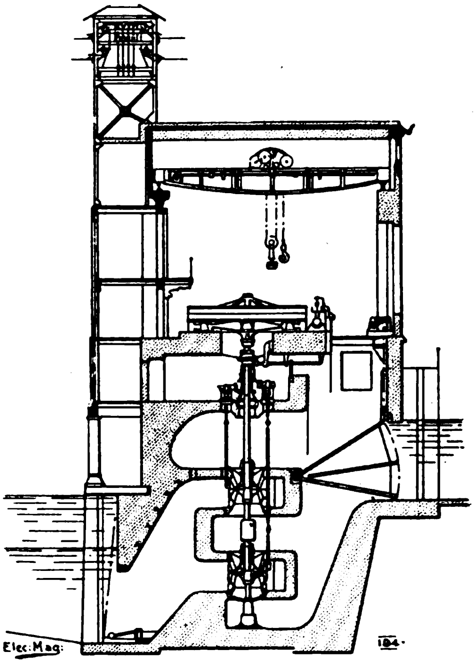
We illustrate below a device known as the "Dyne-Electron," recently exhibited at Newark, U.S.A., and intended for the generation of electricity direct from fuel. Referring to the drawing, A is a hollow carbon cylinder, insulated from the cast iron pot, B, a cylindrical projection, C, of which surrounds the carbon. The projection is perforated to allow of the circulation of the electrolyte. The latter is composed of sodium, chloride of calcium and iron oxide, kept fused at about 390° F, while the cell is in operation, but solid when cold. Gas made by carbonaceous material in a retort, mixed with 30 volumes of air and compressed to about 4 lbs., is introduced into the cell, mingles with the electrolyte, and is discharged at the orifice D. Current at the rate of 1 amp. per 5 sq. in. carbon, at ·9 volts is the output of each couple. Two couples containing 6 cells, aggregating about 150 sq. in. carbon per cell, produced 45 amps. at 1·9 volts. The carbon is the positive pole and the iron pot the negative. The inventor claims to have run the two cells for 27 days and nights, producing 40-60 amps. without deterioration of the carbon electrode, and with only 5 cubic feet per e.h.p. hour, of gas having 650 B.T.U. per cubit ft., representing an efficiency of over 78%, excluding the heat to fuse the electrolyte or power to compress the gas. Mr. J. H. Reid is the inventor of the apparatus, which was fully described in January *Power*. The same engineer is responsible for a gas producer, in which refuse can be employed with other materials readily available at low cost.



Section through Generator

THE HYDRO-ELECTRIC STATION AT CHÈVRES.

The hydro-electric plant at Chèvres, supplying Geneva and district, and situated on the Rhone, is one of the largest and best equipped in Europe. The five turbine sets originally installed have been increased to fifteen owing to the increased demand for current. High voltage current is delivered to Geneva, where numerous sub-stations transform the energy for the lighting and tramway circuits. The first turbines, specially chosen to operate at varying falls, are arranged two in multiple on one vertical shaft, the lower wheel actuating at low water, and at high water both wheels act conjointly. The combination delivers 800 to 1,200 h.p. respectively at a uniform speed of 80 revs. Special provision is made for automatic regulation. The remaining 10 turbines were designed differently, as the adjoining section will show. Water is delivered at the interior of the wheel, and not at the exterior, as in the other sets, consequently a higher speed (120 revs.) is now possible. The adjustment of the gates admits water to either or both of the turbines. The output of water varies from 4,000 to 7,000 gals. per sec. The alternators deliver two-phase current at 2,750 volts 45 cycles. The windings are arranged for coupling in series when monophase current at 5,500 volts is delivered. The machines are of the revolving field type, and by test were found to have an efficiency of 93 per cent. full load. The two turbines together weigh 12 tons, to which the water pressure of 12 tons must be added, to obtain the weight supported by the lower pivot, namely 36 tons. Of the recent alternators installed, the total weight is about 44 tons.



Section through Power House.

GENERAL POWER NOTES.

Electricity in Austrian Railway Workshops.

AN illustrated account of the railway workshops of Luig, Austria, was recently given in *Elek. Zeit.*, from which we gather that 25 three-phase motors are used for cranes, pumps, and drills. All are provided with slip rings, with the exception of two. A 200 K.W. generator delivers the requisite energy at 220 volts.

Tanning by Electricity.

IN America, the country of electric power development, one finds a particular industry built up with the idea of utilizing electricity for power purposes. This is the case in Pennsylvania, where tanneries of modern construction are thus accommodating themselves to new conditions. Milwaukee possesses a power plant where every process from the great boomer press to the fleshing machines is operated electrically. In our next issue we shall illustrate the chief machines used in this particular plant.

Melting Frozen Pipes.

THE superintendent of the Edison Electric Illuminating Co., by the use of a low voltage A.C. current and a 25 K.W. transformer at 50 volts, can thaw 250 ft. of 1 in. iron pipe in twenty minutes, using 18-20 K.W. The secondary cables are connected to the pipe and a fireplug respectively, or to a pipe in an adjoining house. The company send the apparatus out to thaw pipes for those who are wanting water. The charge is not excessive, but little profit is made, as the company rely more on the advertisement than the actual revenue derived.

St. Louis Service Plant.

UNLIKE the Buffalo Exposition, the St. Louis Exhibition will derive its power from steam driven plant. At Buffalo the Niagara transmission lines were drawn upon. A special station is being laid down to supply the St. Louis Exhibition, but this will not be equal to the entire demand, so that a number of the exhibition plants will be utilised. The main station will be of 8,000 K.W. capacity in four units. The contract for the plant is in the hands of the Westinghouse Electric and Engineering Co., who will furnish all the engines through their Machine Co. Two of the large generators will be by the General Electric Co.

Power on the Housatcnic.

THE Housatonic River, Conn., in its course of 123 miles drops 983 ft. between the lakes feeding it and the tide water with which it flows. Great opportunities for power purposes were here presented, and the New Milford Power Co. in 1902 started work on the plain at Bull's Bridge. Water is drawn from a forebay 110 ft. above a bend in the river, by a steel pipe to power house on the river bank. The type of plant is almost identical to those in California where high pressures are quite common, but are seldom met with in the Eastern States. Six generators and two exciters are installed, driven by horizontal wheels. Energy at 30,000 volts is transmitted to Waterbury, New Britain, and other cities, for power work.

A Composite Plant.

A SMALL, but interesting, plant has been laid down in the old blast house of the Irondale Iron Co., Bloomsbury, Pa. The original blowing engines were driven by turbines, and the same pit accommodates the machines for driving the dynamos. Two 250 h.p. wheels are used, and they drive a countershaft by 10 ply belts, the same shaft being connected to a 300 h.p. steam engine, which acts as stand-by during low water or ice jams, etc. There are two two-phase alternators, delivering energy at 2,200 volts 60 cycles. About 50 h.p. of motors are connected to the mains; many of these motors replacing small water wheels.

Roumania and Switzerland Power.

THE mountain streams of Roumania and Switzerland are largely utilised for electric power purposes. At Sinaia, Roumania, a large turbine station is operating at 11,000 volts, and delivering power to the naptha springs at Campina and Bushtenari. Our readers will remember the reference to this in Mr. Gaster's article, "Electricity on the Oil Fields," last month. In our next issue we shall give some illustrations of this interesting plant. At Storoiœ and L'Auberson, villages noted for the production of musical boxes, the introduction of electric power has revived an industry threatened with extinction by reason of the high price of coal.

Electric Winding Engines in a French Slate Quarry.

AT Renagé, France, there is an interesting installation of electric power in a slate quarry where winding engines are employed. Two years ago, at the same place, a gas driven generator and buffer battery were used unsuccessfully, and now a steam plant, nearly 700 h.p., has been laid down. Three-phase 5,000 volt current is generated and transmitted to the various workings, where suitable transformation takes place. The winding engines are supplied with direct current, furnished from a three-phase motor generator set. The two winding engine motors can be coupled in series or parallel, according to the load; this being known to vary from 200 to several thousand pounds.

Electricity in Shipyards.

MR. J. A. ANDERSON recently read an important paper on this subject at Newcastle, and at the outset waived the once debatable question as to the advantages of electricity over steam. He gave some valuable figures relative to the power consumed by various motors under particular conditions. He considered that a combination of three-phase and three wires for lighting and power afforded the best results. In *Cassier's Magazine* for March Mr. Vesey Brown also gives some interesting data on the same subject, and culled from the same field of experience. Mr. H. O. Wraith likewise takes the North-east Coast shipyards as a basis for his paper, on the electrical equipment of such, read before the Leeds Local Section on March 10th. He collates some valuable figures both on apparatus and cost of working the plant.

Venezuelan Power Supply.

THE Caracas Power Company at present draws the bulk of its power from a 800 h.p. hydraulic plant at El Juaire, 12 miles from the Venezuelan capital. Several important power plants are projected in the country, and a number will also be considerably extended, among these are Juan Diaz, Valencia, La Guazra, and others.

The Atalanta Power Dam.

A MASONRY dam is now in course of construction by the Atalanta Water and Electric Power Company, across the Chattahoochee River, U.S.A., destined to furnish power for a 11,000-h.p. generating plant for lighting and power purposes, half the power having been already booked in advance. The present power furnished by the Company is equal to 45,000 K.W.

Short of Water.

AT Brunswick, Me., U.S.A., a queer state of things has been allowed to go on for a few years, and is only now to be remedied. The Electric Light and Power Co. drives its water wheels from a river, which is also drawn upon by a cotton mill, having prior claim to an upper fall. At low water, with the said mill running, the power house has been shut down, a regular interruption of the supply occurring during daylight. The company has now decided to put down a small steam plant.

Hoisting without Loss of Energy in Rheostats.

A Continental contemporary recently contained particulars of an electric hoisting system, in which rheostats were not used. A combination of two shunt motors enables a speed variation of each motor of 2 : 3 can be obtained by varying the field strength. The pole wheel of one motor is stationary, that of the second can revolve while the armatures revolve together. By a variation of the excitation, the pole wheels, by revolving or remaining stationary, cause one or other of the machines to act as generators. The system is applicable to lifts running at a speed of 1 to 2 metres per second.

Interruption at La Haye.

THE proceedings of the Liège Association of Electricians, recently published, contains particulars of a four hours' interruption of supply, at La Haye central station, France. An additional line of feeders was laid down, and connected to the old feeders by short lengths of cable. This broke down at the lead sheathing, and a short resulted. The battery was then disconnected from the bus bars, and the heavy load de-magnetized the generators, extinguishing the lights. One set of units became reversed, and operated in parallel instead of in series (3 wire system, 2 × 120 volts). An assistant, thinking to assist the generators, connected the battery again, forming another short, as the cells were in series across the bus bars. The generators were again de-magnetized, reversed, and picked up a second time, in parallel with the battery. The short now became hot, and enabled the faulty circuit to be localized and cut out.

HOME POWER NOTES.

Important. In our review section this month will be found, among others, criticisms of some important books on electric power. This should be glanced over, as the volumes may prove useful.

Steam More Costly. The temporary steam plant laid down at Redditch is more costly in generating current than was the case with the gas plant.

Floating Coal Depot. A floating coal depot for the British Navy, equipped with electrically driven transporters, has recently been launched at Wallsend. Its capacity is 12,000 tons, and transference can be conducted at 500 tons per hour.

Electricity and Power Gas. The Cheshire Electricity and Power Gas Scheme has entered into an agreement with the Power Gas Corporation for an exclusive licence to work and use the patents and inventions of the corporation within the whole of Cheshire, including Stockport.

Electricity and Winding Engines. Mr. Georgi recently read a paper on electric winding engines before the Newcastle I.E.E., dealing chiefly with the Peebles-Ilgner system. We refer our readers to the last issue of *The Electrical Magazine* for full particulars of the Siemens-Ilgner system, which was then fully described and illustrated.

Electric Piano Making. The piano factory of Messrs. Broadwood & Sons is operated by electric power from 160 K.W. plant laid down for the purpose. By installing their own plant, various processes can be supplied with the necessary steam and electric power, and light is furnished at the same time. The waste wood, amounting to 30-50%, of the total supplied, is also used for firing the boilers. Among the equipment are five electric lifts.

POWER NEWS FROM ABROAD.

Californian Plant. The Kern river plant referred to in our last issue under "Irrigation by Electricity" will have a maximum capacity of 28,000 h.p., and will deliver energy at 60,000 volts.

Vienna Installation.—Vienna has two power houses, for lighting and power respectively. The first has an output of 10,000 K.W. at 5,500 volts, and the latter 6,000 K.W. at the same pressure. A recent article in the *Electrical Review*, N.Y., describes the plant in detail.

Water Power Plants in India. We are given to understand that the sources of the South Indian rivers for generating electrical power offer good prospects of development. The river Godavery, for instance, possesses sites suitable for power plants, but the flow of the Kistna is not constant enough during the year to ensure a regular supply.

Electric Organ. An immense organ will be exhibited at the St. Louis Exhibition, and it will be controlled by electrical means. It has 130 miles of wire, 1,300 magnets, and 1,616 knobs for setting combinations electrically. The coupler contacts clean themselves automatically and current is furnished from a battery at 10 volts.

French Power Plant. The Electro-chemical Society of Saint Beron possesses a power house containing 5 turbine sets giving 3,000 to 6,000 ampères at 80 or 40 volts respectively. They supply 12 electric furnaces producing carbide. A recent issue of *L'Eclairage Electrique* described the plant in full, with illustrations.

Allis Chalmers Plant. The West Allis Works of the Allis Chalmers Co., Milwaukee, famed for their engines, are electrically operated throughout. 900 K.W. of plant is installed, and the motors individually driving the tools are supplied on a multiple voltage system. *The Electrical World*, N.Y., recently described the plant in detail.

Apartment Building Installation. The Pattington Apartment House, Chicago, of 72 apartments and 600 rooms, has its own lighting, heating, and power plant. 3,000 lights are used, and the plant aggregates 200 K.W. An automobile room for 12 vehicles is provided in the basement with charging arrangements, for which the owners of carriages furnish their own connections; current being supplied at a nominal rate.

A French Gas-Electric Plant. An electric power station at Valenciennes, France, where steam engines were originally used, is now being operated by gas. There are four 110-h.p. two cylinder gas engines in tandem, each driving a 100 K.W. generator. A 40-h.p. set is used for the balancing and light loads. Energy is distributed at 250 volts on the three-wire system at from 5d. to 7d. per unit for lighting, and from 3d. to 5d. per unit for power purposes. The cost of gas, from the local company, is about 2s. 2d. per thousand cubic feet.

The extraordinary and rapid developments in electric traction call for a special section entirely devoted to this work. The main systems in vogue or projected in every country will be specifically considered. and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

ELECTRIC TRACTION FOR RAILWAYS.

III. The Coming of One-phase Methods.—(Contd.)

By W. M. MORDEY, M.Inst.C.E., M.I.E.E.

(Continued from page 165).

The starting of a train from rest and accelerating it up to its full speed by one-phase motors, such as those of the Union Co., of Berlin, described in the last article—and of others to be described later—has entirely altered the prospects of one-phase traction as compared with its position two years ago. But it would be unwise, or at least premature, to conclude that self-starting or large-torque one-phase motors are necessarily the best for railway traction under all conditions. Recent developments of one-phase motors have brought them already to a level with direct-current motors so far as torque is concerned, and the inherent qualities of alternate currents have provided the ability to do without wasteful resistances and to give a variable-ratio of supply to the motors; that is to say, to do what cannot be done with direct-currents. With alternate currents any range can be got, without serious waste, from small current and high volts at one extreme, to large current and low volts at the other. And these recent motors may be used in the simple fashion and with the same general arrangement of mounting and driving as we have become accustomed to with direct-current motors. There is very little doubt that these various qualities will go a long way—for many conditions they may go all the way—to make such motors meet practical requirements. But there is another quality which is in some cases very important, and to obtain it some considerable sacrifice may be justified— that is, the ability to make the train a generator when going down hill or when stopping, and so to return energy to the line instead of wasting it in heating the brake blocks. It may be asked whether this is a practical point. For long lines with few stops and with no great amount of inclines it is not very important, and may be negligible. But for town and suburban lines it is certainly a practical matter, for on such lines with short runs, and frequent starting and stopping, a high average speed can only be got by running the trains at a high speed as far as possible and then pulling up quickly, and to do this pulling up by friction brakes is very wasteful of energy. No better example of this

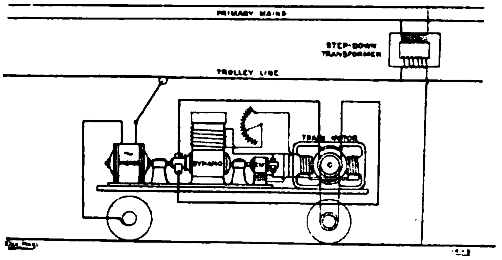


FIG. 1. DIAGRAM OF ONE-PHASE LOCOMOTIVE.
(Ward-Leonard Motor Generator System).

can be quoted than the Liverpool Overhead Electric Railway, referred to in a previous article.[*]

On this line the author finds that of the total energy supplied to the trains about half is wasted in heating the brakes, and only a quarter is actually spent in driving the trains. This is not to be taken as an adverse criticism of the working of the Liverpool line—it is not that. The result is unavoidable with the ordinary direct-current method when used under such conditions. The best way of lessening this loss of energy is to put each station on a slight hill, so that the trains start down hill, and slow down—without braking—as they ascend to the station; but this is not practicable on old lines, and not always on new ones, so other means must be found.

It is about twenty-four years since the late Sir William Siemens pointed out[†] that, if two trains were driven electrically by a common source of energy, a train going down a hill would help one going up almost as if they were connected by a rope. Various attempts have been made with direct-current motors for applying the principle of the reversibility of the dynamo in this way—of making the dynamo on the train act as a motor to drive the train, and as a generator when the train has energy to spare. With ordinary direct-current motors this is difficult. With multiphase alternate motors it is less difficult to get such a reversed action, but it is not got through a sufficient range of speed. This action can, however, be got through a very long range of speed by a system first suggested by Mr. Ward Leonard, a good many years ago.[‡] Mr. Ward-Leonard had in view the application of one-phase alternate currents to railway traction, but it does not appear that he realised that his ingenious system possessed the special quality which now makes it so interesting. He was aiming at getting self-starting qualities with one-phase currents, and his solution of this problem—although never put into practical use—remained the only practical one, till the advent of the recently invented large-torque one-phase motors. The system will be understood from Fig. 1.[*] The locomotive carries, in addition to the train motor or motors, a motor-generator consisting of a one-phase alternate-current motor driving a dynamo. This motor-generator, which is kept running, supplies a direct-current to the train motors, which may be of the ordinary direct-current type. It will be evident that the one-phase motor may have only very poor starting qualities, as it never has to start up with any load. When once up to speed, however, it forms a satisfactory means of driving the dynamo, and in combination with the dynamo it can be arranged to develope a very large starting effort on the train motors. It forms a variable-ratio transformer capable of working through a very wide range without the need for any regulating resistances in the main circuits. This is attained by varying the field of the dynamo, enabling it to give a large current at low volts for starting, and, as the speed of the train increases, any volts up to its maximum by perfectly smooth gradations. Similarly, the arrangement is capable of working with reversed action, returning energy to the line through a wide range of speed. This is done by lowering the excitation of the dynamo till it acts as a motor (receiving energy from the train by way of the train motor) driving the one-phase motor and so enabling the latter to act as a generator working back on the line and helping the generating station.

This system is not nearly so simple as the large-torque one-phase motors that are now available, but it has qualities of great interest and may quite possibly still find applications of value. It must not be lost sight of, that even on one railway there may be room for different kinds of driving arrangements to meet different kinds of service. It is therefore with pleasure that illustrations are given of the modified Ward-Leonard system as worked out by the Oerlikon Co., of Switzerland; in par-

---

[*] *The Electrical Magazine*, No. 1, Vol. I., page 46.
[†] Journal of Soc. of Telegraph Engineers, IX. 301.
[‡] British Patent No. 14,509 of 1891.

[*] From Proc. Inst. of Civil Engineers, Vol. cxlix., Feb. 1902, where a detailed examination of the system will be found.

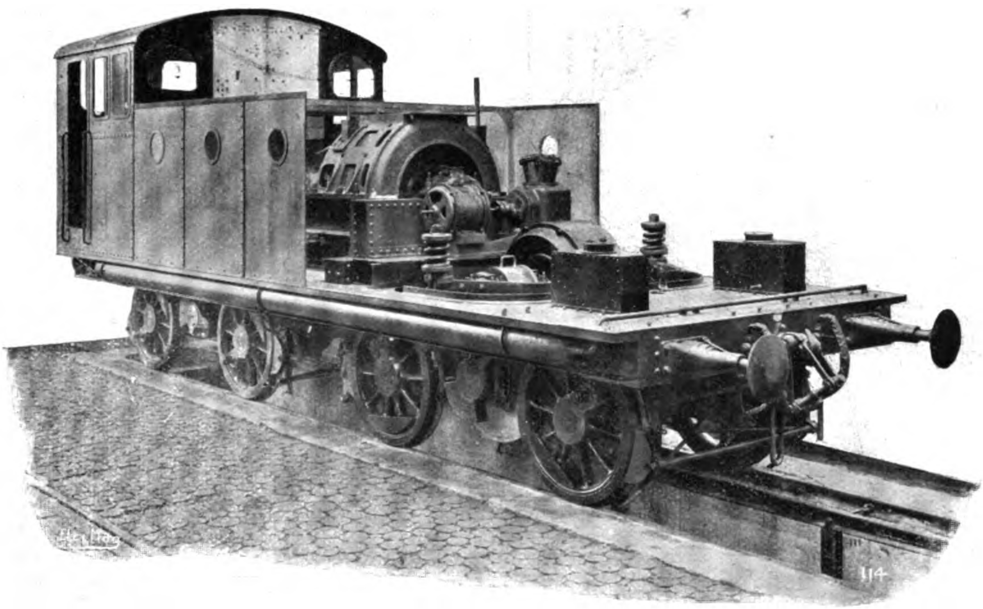


FIG. 2. 400 H P. ONE-PHASE LOCOMOTIVE, OERLIKON CO.
(Ward-Leonard Motor Generator System.)

ticular as this enables attention to be drawn to a very simple and ingenious current collector or trolley which has been devised by the Oerlikon Company, specially for one-phase alternate-current railway working, the usefulness of which is not, however, confined to such a system, as it is quite well adapted to any system of traction on which large currents are not required.

The work of the Oerlikon Company in developing one-phase railway traction has been carried out quietly and in a true engineering spirit, by careful study and long-continued experiments. Both the general features and the details of its apparatus are of great interest.

Fig. 2 shows a 400 h.p. locomotive constructed by the Oerlikon Company on the Ward-Leonard system. The large machine in the middle is the motor-generator. There are two train motors, one only of which is visible in the illustration. The motor part of the motor-generator is a one-phase non-synchronous motor having a stator wound for either 15,000 or 700 volts—capable therefore of working direct from a high pressure line without transformation, from a transformer on the locomotive, or from a low tension line. So far as this motor is concerned, no regulation or control is needed. It is started up without load and runs at practically synchronous speed. The generator is separately excited by a small exciter for convenience of control.

In the working of the train the one-phase motor of the motor-generator needs no control. When a load comes on to the generator, the motor responds by taking more energy from the main conductor; when the load ceases the motor ceases to take energy—except enough to keep it running up to speed. The control of the train motors is a simple matter, as they are supplied with current by the generator, the voltage of which, by a resistance in the exciting circuit, is regulated to what is necessary for the motors. Although it appears to be a complicated system, it is in reality very simple and easy of control.

The Oerlikon Company's arrangement of overhead conductor and trolley or contact arm is ingenious and attractive. It will be remembered that in the Berlin-Zossen high speed experimental railway, the conductors were placed at the side of the track, contact being made by a collector resembling the ordinary bow, but arranged to rub on the sides of the wire instead of—as often used on Continental railways—

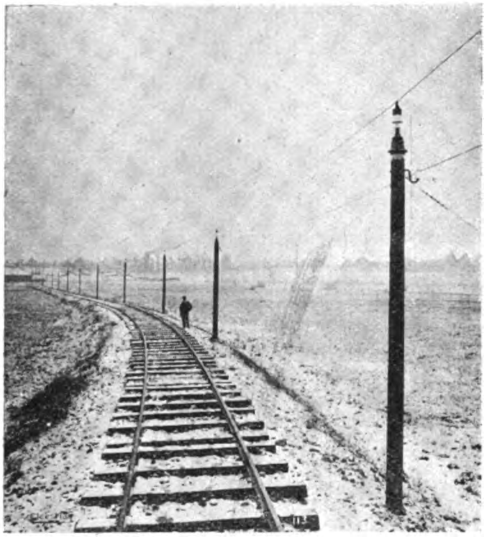


Fig. 3. Overhead Wire for One-phase Railway.
(Oerlikon Co.'s System).

under it. The Oerlikon Company have gone further and have devised an arrangement of a rod or bow capable of collecting either from the side or the top or the bottom of an overhead conductor, and of automatically adapting its position to suit the position of the conductor.

The collector consists of a slightly curved rod or bow, pivoted at one end on an axis parallel with the motion of the trail, and capable of movement through an angle of about 180°. This rod is carried by a standard above the roof of the locomotive or train, and is controlled by a spring which forces it into light contact with the conductor, and enables it to follow the conductor through a large range of positions relative to the locomotive; and by a movement of the standard a still greater range can be got. This device permits of the conductor being placed either at the side of the track or over the locomotive.

Fig. 3 illustrates the simplest of all arrangements of the conductor, the wire being mounted direct on the top of the posts at the side of the track, a very excellent position, the advantages of which are obvious. Fig. 4 shows a locomotive with the rod making contact with this line. The rod extends out sideways, presses on the top of the conductor, and slides along it as the locomotive moves. Fig. 5 shows, more closely, the top of the locomotive with the collecting rod resting on the conductor. Fig. 6 and Fig. 7 are views of the top of a locomotive. In Fig. 6, the collector is seen to be making contact with the under side of the conductor, while in Fig. 7 it is pressing against the side of the conductor. With this collector, section insulators—which would hardly be practicable at very high pressures—may be dispensed with, as shown in Fig. 8, the two wires being carried near one another for some distance, with a twist, so as to transfer the collector from one to the other. The variation of the position of the standard that supports the collector—and, therefore, the point about which it moves—will be noticed in comparing Figs. 7 and 8. This position is under the control of the driver. At points, the wire is carried over the track, the collector assuming a horizontal position under the wire as in Fig. 6, and simply slipping under a fork in the wire.

It is not necessary to refer to the numerous details which the Oerlikon

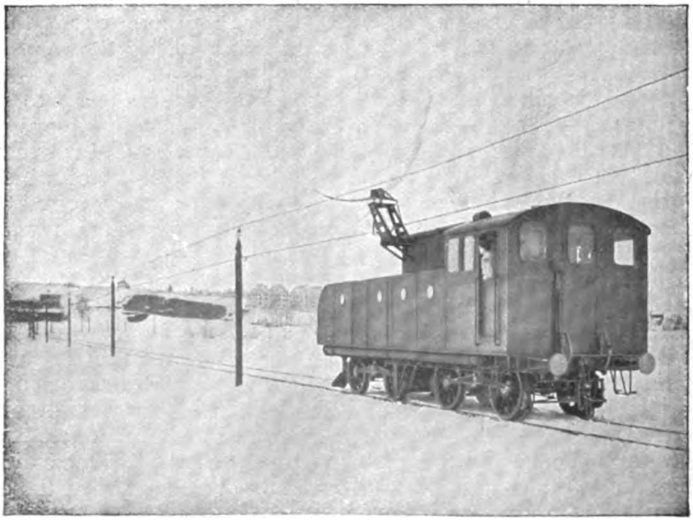


Fig. 4. 400 H.P. Oerlikon Locomotive, Collector and Conducting Line.

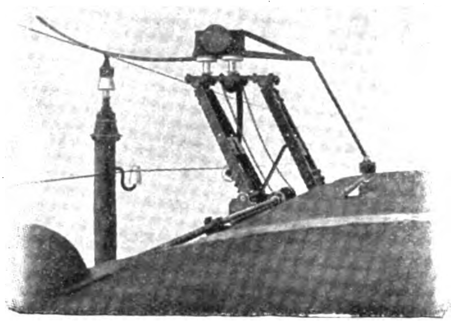


Fig 5 Collector in Normal Position on Top of Conductor

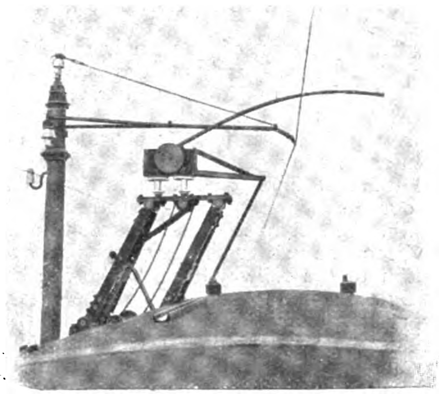


Fig. 6. Collector on Under-side of Conductor.

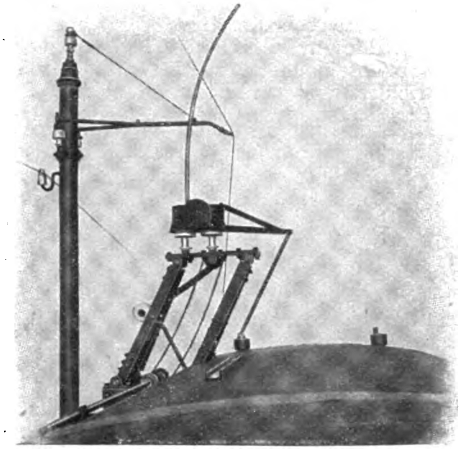


Fig. 7. Collector on Side of Conductor.

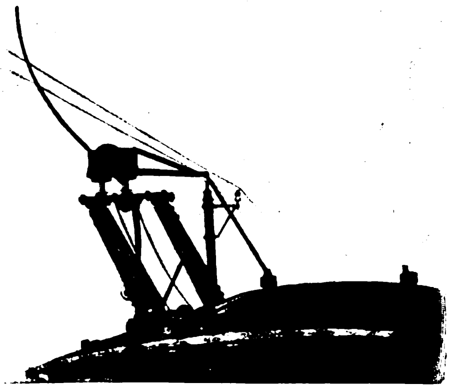


Fig. 8. Collector Passing from One Conductor to Another.

Company has worked out for applying this method of collection to single or double lines. Sufficient has been said to show that this method answers practical requirements very fully. As the change of angle of the conductor will always be gradual, there should be no difficulty, even at high speeds—in getting the collector to follow the angle quickly enough.

One of the differences in electric tramway practice between, on the one hand, Great Britian and America, and on the other, the Continent, has been, that on the Continent the bow has been used a great deal, while we have used the trolley wheel. It was interesting, therefore, to notice, during a recent visit to Germany, that on tramways, the bow was very generally giving way to the trolley wheel. The explanation given was that the wheel caused less wearing of the conductor, so that in spite of the greater convenience of the bow at points and crossings, it was being displaced.

The Oerlikon collector is a bow, and will probably cause a certain amount of wear, but this must be very slight, as the mass of the bow is small, and it exerts only a small pressure. Even if there is some wearing of the conductor, the Oerlikon collector has so many advantages that, for railway, work it seems likely to come into extensive use. *(To be continued.)*

W. M. Mordey.

Railways and Tramways.

By G. W. de TUNZELMANN, B.Sc., M.I.E.E.

The speeches of the chairmen at the recent half-yearly meetings of the great railway companies, and the directors' reports to the shareholders, supply most interesting material for the consideration of all interested in problems of electric traction, and this material is dealt with in some detail in our finance and legislation section this month. The competition of electric tramways has become a matter of very serious contemplation to the railway boards, who are being rudely awakened to the fact that the generally favoured policy of masterly inaction and turning a deaf ear to the demands of the travelling public, has become quite untenable. Railway shareholders are notoriously long suffering and hard to arouse, but falling dividends will overcome even their apathy, and the directors of the old style are at last beginning to realise that they must either follow the example of the progressive minority of their colleagues or be prepared to face the loss of their positions.

The problem before them is well defined, and the general outlines of the solution are clearly indicated by existing experience. The public demands, and will insist on having, rapid transit facilities as cheaply as possible. For long distances the railways are supreme, and have no outside competition to fear. For quite short distances, on the other hand, they, with their fixed stations, cannot hope to compete with electric tramways along the principal streets.

As far as the suburban service is concerned, the problem for railway managers is so to increase its efficiency as to reduce to as small limits as are economically possible the distances below which the tramways are more convenient than the railways. That this limit can be brought to a pretty low value is shown by the experience of the Paris Metropolitan electric railway, as well as by American experience.

The Paris tramways have found the Metropolitan, with its splendid train service, as formidable a competitor as the Central London Railway has proved to be to the omnibuses. Some of our steam railways are finding, on the other hand, that their receipts are being considerably diminished by the competition of electric tramways. Electrification would enable steam railways feeling the results of such competition to obtain the maximum possible improvement, both in the schedule times and in the frequency of service, and so to reduce the limits of distance, below which the tramways will be preferred to their minimum values.

The railway directors naturally hesitate before incurring the very considerable expenditure involved in electrification, especially in the present condition of the money market, and are endeavouring in various ways to reduce the transit times. This is good as far as it goes, and there can be no question that some of our railways might effect very considerable improvements in this direction without abondoning the use of steam locomotives.

On the well managed steam lines, however, the limit has been nearly reached, and any considerable further improvement will only be attained by electrification.

It does not appear economically possible, with trains worked by steam locomotives, to give anything approaching the frequency of service both during times of light and heavy traffic, that is attainable with the greater flexibility ot the electric railway. But a still more serious obstacle is that of obtaining and maintaining the high acceleration possible with electric driving. A high initial acceleration is possible with steam locomotives, but this can only be raised to a value at all comparable with that usual on electric lines by such an increase in weight as would involve the practical reconstruction of most of the bridges. Moreover, this initial acceleration cannot be maintained for any length of time, while in electric driving it can be kept practically constant until nearly full speed has been attained. In the case of railways which are only partially dependent on suburban traffic, the advent of the electric tramway may prove a very considerable benefit, as has already been found to be the case with some of the American lines, where the effect of the tramways acting as feeders to the through lines at the various suburban centres traversed has far more than counterbalanced that of the competition within the suburban area. The directors of our own Great Western Railway, and some other companies, have recognised the importance of this feeding of the through lines, and in places where there are no tramways have established feeder motor car services. The introduction of steam motor cars for this purpose on the Chalford and Stonehouse branch of the Great Western Railway has already increased the traffic to no less than eight times its previous amount.

ALTERNATING CURRENT SIGNALS.

An interesting system of automatic block signals has been introduced by the Pneumatic Signal Co., of Rochester, N.Y. The essential features of this system are:

(1) The use of alternating current for signalling, and the employment of the traffic rails for the signal circuit as well as for the return power circuit. (2) The use of a special bond which offers little resistance to direct current, but effectually chokes back alternating currents. (3) The use of special relays, at the entrance to each block, which control the operation of the signals.

Fig. 1 is a diagram of the track connections. By reference to this, it will be seen that X represents the block rail, Y the common rail, L the alternating current transmission line conveying power

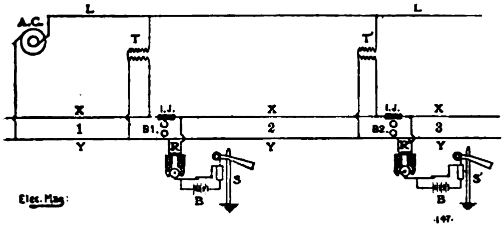


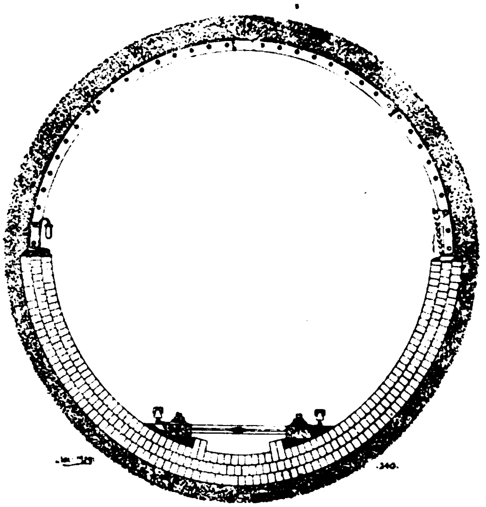
Diagram of Signal Connections.

from A C, the alternating current generator at the station, to the signalling apparatus on the line. The signal blocks are represented in their order as 1, 2, and 3. T is the transformer furnishing current for the track circuit to block No. 1, and T^1 performs the same service at block No. 2. R and R^1 respectively are the relays governing signals S and S^1, while I, J indicate the insulated joints on the block rail, around which the special bond is utilised; and B_1 and B_2 are similar bonds which make the block rail (X) electrically continuous. The operating mechanism consists principally of an electric motor with a train of gear wheels, and an electrical control for making and breaking the connection between the motor and the blades. The motor is entirely enclosed, the commutator end having a glass shield. The principle upon which this system is based, is that, while it is impossible to keep two direct currents of different potentials separate on the same conductors, an alternating current may be introduced to perform one of two given functions, and if proper apparatus is supplied to keep each current from interfering with the instruments designed to be operated by the other current, the track circuit becomes feasible and practicable. By this apparatus one current may be used to operate the car, and the other to operate the track circuit for controlling the signals, without interference or interruption. It has been the aim of the inventor to arranged the system so that no possible combination, or failure of parts, can produce a clear signal when a danger signal should be shown. For instance, the breaking down of the insulated joints between the blocks will result in a danger signal; direct current from any foreign source cannot affect operation; and stray alternating currents will also fail to operate the relay.

THE GREAT NORTHERN AND CITY TUBE RAILWAY.

This line, which was opened to the public on Feb. 14th last, runs from Moorgate St. to Finsbury Park, a distance of about 3½ miles, and has occupied about four years in construction. There are intermediate stations at Old Street, Essex Road, Highbury, and Drayton Park. Trains run at intervals of three minutes, and the whole run occupies 13½ minutes. A twopenny fare is charged, with penny fares between intermediate stations. The tunnels are 16 ft. in diameter, those on the Central London Railway being 11 ft. 8 in., and those on the City and South London, 10 ft. 6 in. The capital outlay per mile, however, has been about the same. Greathead shields have been used throughout by the contractors, Messrs. S. Pearson & Son, Ltd., for driving the tunnels. The shields were of a somewhat more powerful type than is usually employed for this class of work.

A noteworthy feature is that, instead of lining the tunnel with complete iron rings, the upper half only has been lined with cast iron, a lining of vitrified bricks being employed for the lower half, as shown in the accompanying illustration. This combination of materials greatly diminishes the resonance, and the noise and vibration. The platforms are constructed entirely of iron and concrete, and the signalmen's cabins are also fireproof. Each train consists of three motor cars and four trailers, each seating 54 and 56 passengers respectively. Westinghouse quick-acting brakes are employed. The British Thomson-Houston multiple control system has been adopted, on account of its suitability for a rapid and frequent service between stations at comparatively small distances apart, and for the quick handling of the trains, which can be run in either direction, thus avoiding the necessity of shunting. Each motor car is driven by two 125 h.p. motors. The generating station, situated in Poole St., alongside the Regent's Canal, contains four vertical cross-compound steam engines of a normal capacity of 1250 h.p. each, running at 160 revolutions per minute, and a steam pressure of 150 lbs. per sq. in. They are direct-connected to four standard B.T.H. generators, normally rated at 800 kilowatts, and capable of carrying a 50% overload for ten hours, and a momentary overload of 100%. They are compound-wound, to give 525 volts at no load, and 550 volts at full load. Steam is supplied from ten Davy-Paxman "Economic" boilers.



Section through Tube.

The Electrical Magazine has met with such a body of support that its position among technical journals is now doubly secure. Whatever branch of electrical engineering you represent, do not miss a single copy. To avoid disappointment and delay, fill in a subscription form and mail us.

After the Fire.

As a direct outcome of the fire on the Paris Metropolitan Railway the company are abandoning all cables carrying large currents on the trains. The electro-pneumatic turret control system, to the extent of 100 sets, will be installed as quickly as possible. This system, as our readers are aware, is exploited by the Westinghouse Co., and, in addition to the compressed air, requires but a pressure of 14 volts to operate it.

Predetermination of Temperature Rise in Electric Railway Motors.

In a paper presented to the American Institute of Electrical Engineers in October, Mr. C. T. Hutchinson, after referring to a previous paper in which he described a method for determining the motor capacity and energy required for any given schedule speed, shows how the method may be extended to include the predetermination of the rise of temperature of the motor when the constants are known on which the rise depends.

The Alternating Current Railway Motor.

An interesting paper with this title was communicated to the American Institute of Electrical Engineers in January. The author is able to speak from personally made trials of some of the principal types of alternate current motors which have been employed for railway purposes, and gives interesting results of tests which he has made on them in addition to setting forth the theory of their action and comparing their characteristics with those of the standard continuous current railway motor.

Ilford Corporation Tramways.

Our contemporary, *The Tramway and Railway World*, in its issue of Feb. 11th, gives a very full illustrated account of this system. The Broadway lay-out is stated to be, with the exception of a junction at Leicester, the largest piece of special track-work yet laid down in the United Kingdom. It is interesting to note that it was constructed and laid out in the first place at Hadfield's Steel Foundry, and when being placed *in situ*, the whole of the work was put together again without difficulty or alteration.

The capacity of the five generating sets at present installed aggregates 1,600 kw., but a sixth set of 1,000 kw. capacity is about to be ordered.

Efficient Variable Speed A.C. Motors.

At a recent meeting of the Société des Electriciens, M. Latour gave a brief summary of the methods hitherto employed for varying the speed of alternate current motors. Resistances in the rotor circuits are uneconomical. Where two motors are running simultaneously, Ganz's cascade method may be adopted, but it has many drawbacks. Inventors have lately reverted to a commutator as affording the simplest solution. For mono-phase motors a commutator, as is well known, provides not only for variable speeds, but also removes the starting difficulty. M. Latour, in a series motor of this kind, provides two extra brushes at right angles to the ordinary brushes. By varying the position of these, not only can the speed be varied, but it is also possible to recuperate energy when braking. Instead of moving the brushes the stator connections can be varied, a plan which may be adopted for traction motors.

Third Rail High Speed Trials.

The Central Hudson tracks between Schenectady and Hoffmans, N.Y., are to be the scene of some interesting speed trials of the third rail system. Engineers are already at work on the road, and the trials will probably commence in the early spring. Some records in transportation are expected.

Massachusetts Traction.

The Massachusetts Railroad Commissioners report that during 1903, the number of passengers carried on steam-railroads is larger than the number carried in 1893. When the electric railways first started competition on the steam roads in the State, 123 million passengers were carried as compared with 505 million odd on the electric railways.

TRACTION NEWS IN BRIEF.

Calcutta Tramway Extensions. We understand from the *Contract Journal* that an important extension of the Calcutta electric tramway system is contemplated in the near future.

Double-decked Cars at Nottingham. The continuous wet weather has induced the Committee to order, for trial, two cars of the type common in the States, in which an upper deck covering is provided as a protection against the weather.

Weld Rails at Glasgow. The rails at Glasgow are now being continuously welded by the Thompson process. The Lorain Steel Co., Ohio, the contractors, have built in Glasgow, four of their welding cars. The plant is also being used for brazing copper ground cables to the rails.

Bath Tramways. The generating plant comprises: three 200 kw. (Yates and Thom) Westinghouse generators, running at 100 revolutions per minute; and one 75 kw. Westinghouse unit, running at 300 revolutions, used for lighting and traction. There are two 15 kw. boosters.

London Traffic Commission. We understand that Mr. W. B. Parsons, of the Rapid Transit Commission, New York, is coming to London, at the invitation of the Royal Commission, to give evidence on traffic problems. During his absence the subway work in New York will be in charge of Mr. G. L. Rice.

London County Council Tramways. The Greenwich and Walworth Road sections of the Council's tramways in South London, were worked electrically for the first time on the 17th of January. A third section will shortly be ready for working electrically. Except for a few minor variations, the track and conduit are on the same lines as those of the Tooting section.

Lightning Post. Italy is to be the scene of some novel trials of overhead carriers, resembling "telphers," intended for the carriage of small parcels, mails, etc. The development of the system on a commercial scale would materially reduce the time occupied in delivering mails. The carriers, of aluminium, weigh 1¾ cwt. each, and are driven by an automatic motor, the whole running on overhead wires.

Electric Railway Signalling. Mr. W. H. Jordan, of New York City, has recently patented a method of signalling in which local batteries are dispensed with, the main line current being employed for operating the signals. A shoe on the car makes contact between the main line conductor and the section of signal rail or wire, through which a portion of the current passes through the signalling apparatus to earth.

Adoption of the "G.B." System. The Musselburgh Town Council have unanimously agreed to adopt the "G.B." surface contact system in connection with the electric tramway to be laid between the Joppa terminus of the existing cable line and Levenhall, at the east end of Musselburgh Links. A full description of the "G.B." system appeared in our February number.

North Eastern Troubles. The electric tram trials of the North Eastern Railway Co. have been temporarily stopped through the breakage of an engine shaft at the Wallsend station. Some difficulty has also been experienced in collecting current from the third rail, owing to the snow and frost. The opening of the lines will be delayed through these delays.

LIGHTING and·Heating

Under this heading the development of lighting and heating by electricity will receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., will be comprehensively and impartially described and illustrated.

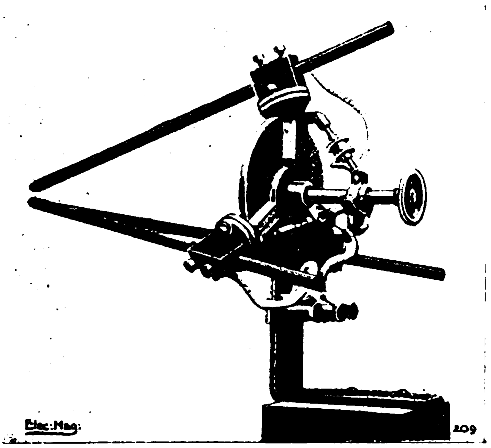
The Present Position of the Cooper Hewitt Lamp.

By W. H. STORY, M.A.

If any of our readers want to see this lamp, it might be well for them to walk some evening down Cheapside, where it is being used in a shop window for advertising purposes with very good results. The display is certainly striking, the three or four long tubes, which occupy the shop front, being easily noticeable at a great distance. The latest facts discovered have been well set forth by Dr. Max von Recklinghausen in his paper before the American Institute of Electrical Engineers. The characteristic curve of the lamp, connecting volts and amperes, has a very decided knee or bend. It is just at the point where this bend occurs that it is most economical to run the lamp. At points where the voltage is higher, the efficiency sinks considerably, so much so that at 50 per cent. above the normal voltage, the efficiency has fallen from 0·3 to about 0·8 watts per c.p. Now, in the lamp the main resistance is centred at the negative electrode, and in order to diminish this resistance it is necessary to make the negative electrode of some substance which easily disintegrates. Mercury is the best substance, and though it takes several thousand volts, even in some cases 30,000 volts, to start the disintegration, and break down the resistance at the surface of the mercury, yet when once this disintegration is effected the lamp will continue to burn at a much lower pressure. If, however, the current is interrupted for the minutest fraction of a second, the lamp goes out and cannot be re-started until the breaking-down pressure is again applied. For this reason single-phase lamps seem an impossibility. The present lamps are started by a quick break switch under oil, and as the 120-volt current is passed through a kind of induction coil, having 2,000 turns round an iron wire core, the voltage generated by the break is sufficient to start the lamp. Lamps as at present made will stand a variation of 5 or 10 per cent. either way; but with a variation of 15 per cent. the conductivity of the vapour goes down and the lamp goes out. The normal current for a lamp is 3 amperes. If the current falls below about 1·2 amperes, the negative electrode ceases to disintegrate, and the lamp goes out. If the voltage rises too much, the light gets brighter, the lamp gets too hot, increasing the resistance of the vapour to such an extent that an unstable condition is reached and the lamp goes out. A lamp taking 3 amperes at 120 volts, 1·2 amperes would require about 80 or 90 volts. They will not work if they have more than the minutest trace of any other gas besides mercury vapour. In 1880 Rizet proposed to add a little nitrogen by way of getting a redder light; but this seems to be a practical failure, though it undoubtedly reddens the light. The present lamps have almost uniformly a life of 2,000 hours. The candle power seems to drop about 10 per cent. owing to a slight discolouration of the glass. The life is really limited by the badness of the vacuum, caused by air leaking into the bulb through the platinum wires sealed into the glass. The candle power of an ordinary lamp is about 700. The longer a lamp is made the more efficient does it become, seeing that the volts used in overcoming the resistance at the negative electrode, which do no useful lighting work, form a smaller percentage of the whole.

A THREE-PHASE ARC LAMP.

Various attempts have been made from time to time with three-phase current for arc lamps, but so far nothing has resulted of practical importance. It seems likely that they would result in some economy from the point of view of power required; but the stumbling block is probably the mechanism by which the arc is regulated. Some interesting studies on the light-giving power of the arc have been made by Monsieur Paul Mercanton, and published in *Eclairage Electrique*. He certainly evades the difficulty of regulation by adjusting by hand. His apparatus is shown in the photograph. The carbons are inclined to one another at an angle, and are slid forward or backward by turning the screw, shown at the back of the plate on which the carbons are carried. Each carbon can, however, be independently adjusted by a small nut with right and left handed threads. It was found impossible to obtain any results with ordinary carbons; presumably the arc was too unstable. With hollow carbons, the lamp worked well, and also with the so-called "effect" carbons, made for use with the Bremer lamp. It will be noticed that the carbons together form a kind of pyramid. With a frequency of 38.5, the lamps worked perfectly steadily, and the results obtained can be seen in the following figures. With effect carbons, 290 mm. long, and 8 mm. diameter, taking 20 amperes per phase at about 37 volts, with a frequency of 38.5 periods per second, the results were as follows:—



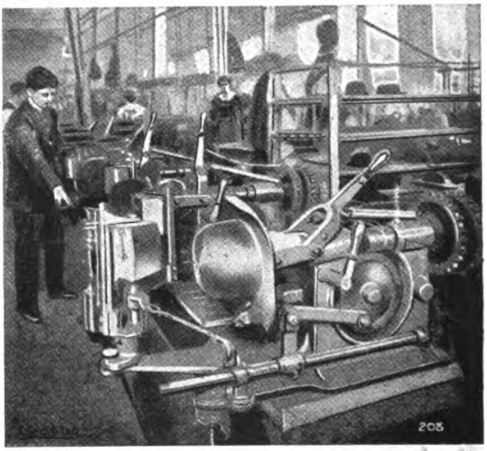
Three-phase Arc Lamp.

Angle	Hefner c.p.	Watts	Watts per c.p. (Hefner)
0°	6.920	1,107	0.160
22·5°	7.810	1,170	0.150
45°	7.150	1,158	0.162
67·5°	6,090	1,120	0.184
90°	5,670	1,230	0.217

Using hollow carbons, 220 mm. long, 8 mm. diameter, and taking about 16 amperes per phase at 51 volts and a frequency of 51 periods per second, the watts per c.p. of light emitted in a horizontal direction were 0.2. These figures show that such an arc would burn under very economical conditions if made to burn without constant attention.

ELECTRIC HEATING IN THE HAT TRADE.

Heating by electricity as applied to hat making seems to be something of a novelty, but in the large firm of F. Berg & Co., in America, who turn out nearly 4,000 hats a day, the application of electricity to the processes of manufacture has superseded that of gas, which was formerly employed. The precise processes probably interest specialists only, but the method by which the heating is effected is at once simple and ingenious. The conductor in the heating apparatus consists of a thin metallic film on a layer of mica, a second piece of mica being used to cover the metallic film. The whole is then encased in sheet metal, on the outside of which terminals are fixed. The box of sheet metal is merely slipped inside and pressed against the thing which is to be heated; these are mostly moulds of various sizes and shapes, and in this factory 100 K.W. of electrical energy are said to be applied to the purpose of heating these devices, with very satisfactory results. A large amount of the machinery is automatic in its action, and merely requires a little casual attention. Such, for instance are the ironing machines, a large number of which are looked after by a boy, who merely supplies them with the raw material in the shape of hats, and then leaves the thing to its own devices, the ironing being, of course, done by blocks or moulds, which are electrically heated as described above.



Electric Heater, showing Hat in Position.

WRITING IN LIGHT!

Since the introduction of the first electric sign with time switch and fixed lettering many improvements have been effected; in fact, illuminated script has been reduced to a fine art. The latest comer is the Talking Sign of the British Electric Signs Co., who have brought out a combination device which will do almost anything in sky writing at night. Essentially, the system comprises a number of monograms, each of which can singly flash out all the letters of the alphabet. Fig. 1 illustrates the diagram of such a monogram,

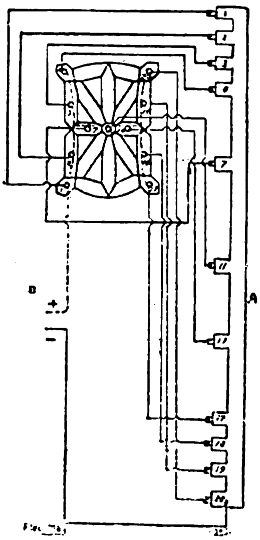


Fig. 1.

and from this the tube lamps in their cells and the connections can be seen. The cells are metal troughs, in which tube lamps are embedded, so that the particular letter stands up sharp and clear when the tubes are illumined. Twenty-one compartments comprise a complete monogram, and twenty-one wires connect it with a motor driven commutating device, forming the discriminating element. The commutators (one for each monogram) are 12 in. long, 8 in. high, mounted on slate base 4 in. wide.

The details of this portion of the apparatus cannot be treated with here, though it is by no means complicated. In Fig. 1 the wires are shown in service for the letter H, B being the return wire. By the introduction of suitable "letter bars" into the various commutators, any desired wording can be obtained and written out in light a word at a time, the motor ensuring continuance until it is either stopped or the sign changed. Fig. 2 illustrates the name of this journal as displayed recently at Liverpool. The entire system opens up quite a new sphere for the electric sign, and we shall not be surprised to see some striking advertisements displayed through its agency. For making anything public, from the position of belligerents to the result of an election, it is equally serviceable, and should, we think, form a valuable adjunct to any public building or commercial house.

⁂

LIGHTING AND HEATING NOTES.

Arc versus Incandescent Lamp.

Although the arc lamp has a substantial start of the incandescent lamp in the history of electric lighting, the state of affairs is very much the reverse at the present time. Both have undoubtedly their own fields of action, and neither seems very likely to encroach on the preserves of the other. In America, it is reckoned that electric lighting companies derive 52 per cent. of their incomes from incandescent lighting, and about 28 per cent. from arc lighting. In England it is probable that an even larger proportion than this is derivable from the incandescent lamp, seeing that arc lighting, which is generally street lighting, is very frequently done on a very unremunerative basis.

Belfast Progress.

The rate at which the electric lighting business continues to spread is matter for satisfaction. In Belfast they were lately able to report that during the last year their output had increased by half a million units, or about 33 per cent. If this is to continue at compound interest, as it were, it would seem as if the whole world would sooner or latter fall willing victims. But this is a point about which experts differ, as was shown at the arbitration proceedings in Marylebone last year. There was at those proceedings no sort of general agreement between the various witnesses as to what the load of the Metropolitan Electric Supply Company might be expected to be in Marylebone in the year 1931; but as the rival witnesses set out with the intention of proving totally different contentions unaniminity was hardly to be expected. In Belfast they seem to be well pleased with the situation; and as the Corporation own both the gas and the electric light undertakings, it almost looks as though the time had arrived in which the lion shall lie down with the lamb.

Crystal Palace Gas Exhibition.

The Crystal Palace Gas Exhibition, recently closed, does not seem to have been an unmixed success for the exhibitors. The Palace itself, with its ancient associations with the Great Exhibition of 1851, is an ideal spot for such gatherings, and probably there was something unattractive about the wares exhibited to account for the failure. There is little alluring novelty about the latest gas-saving device, though no doubt such devices should be expected to appeal to the business mind. More probably the fact is that gas engineering is tending, as Professor Perry would say, to become a trade or business, and consequently few persons visit such exhibitions, be they experts or laymen, when they know they can get all they require from the local ironmonger. Commercially this is no reason for underrating the competition of gas. Indeed, quite the reverse. It shows that such a position has been reached by the gas-lighting fraternity that they can complacently await the issue with a light heart.

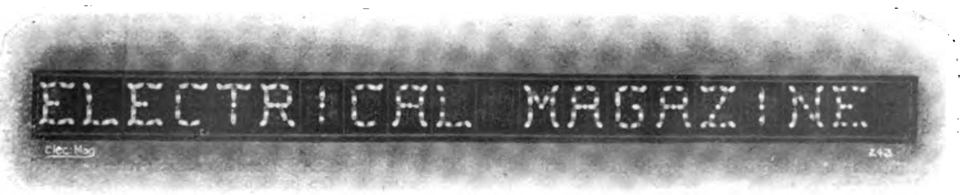


Fig. 2. Sign Displayed at Night.

The Dowsing Hot Air Bath.

MR. DOWSING has extended the business of his well-known radiators to the hospital world. By his treatment the patient goes to bed, and is then submitted to a temperature of 300° F., which emanates from radiators which are placed in the room. It is said that even a temperature of 400° does not necessarily cause any discomfort. Possibly this may be due to the extreme dryness of the atmosphere. In a Turkish bath the temperature rarely rises above 175° F., and if therapeutic effects can be produced at high temperatures, the Dowsing system has much to recommend it. Moreover, the ease with which the temperature can be controlled adds to the simplicity of the working arrangements, and we are, therefore, not surprised to find that it is in high favour and has achieved good results.

The Osmium Lamp.

NEWS reaches the outer world from time to time about the coming osmium lamp, and the latest information given by Professor F. G. Baily, in the *Electrician*, seems to show that a 32 c.p. lamp may be expected to take 1·1 ampères at 55 volts. As we already know, the voltage at which these lamps will have to be run, as at present made, is very low; but, on the other hand, the efficiency does not seem to be abnormally high, as compared with that of the Nernst lamp, for instance. According to Professor Baily's figures, the efficiency works out at about 1.9 watts per c.p. Professor Wedding has reported that the average life of the lamps which he tested was about 1,900 hours, and that the efficiency fell off from 1.7 to 2.1 Watts per c.p., which is by no means a bad result. Still there would seem to be some hitch somewhere, seeing that nothing is being done towards commercial exploitation, in this country at any rate. The lamps are said to be sold in Berlin at the rate of nine shillings each; but, in so far as we know, none are for sale in this country.

Why the Welsbach Mantle Becomes Dim.

IT is a matter of common remark that the well-known gas mantle only looks at its best when it is new; but the cause of this has not till lately been properly ascertained. The mantle is composed of about 99 per cent. of thoria and 1 per cent. of ceria. Thoria is a very refractory substance, and will withstand the highest temperatures without fusing. Ceria is, however, a very different substance, and can be easily fused in the oxyhydrogen flame. It seems too, from modern tests, to be distinctly volatile at the temperature to which the mantle is subjected. This is more particularly noticeable in the hotter part of the flame, which is in the middle of the length of the mantle, and least of all at the bottom, where it is coolest. Thus, after 900 hours, a mantle which contained 1 per cent. of ceria at the start was found to have 1 per cent. at the bottom, 0.37 per cent. at the middle, and 0.72 per cent. at the top. To this volatilisation of the ceria, the falling off of the light is attributable, and probably after 500 hours, the light has fallen off to such an extent as to be seriously noticeable, even if it has not before this come to grief from mechanical disintegration.

The Fire at the Iroquois Theatre, Chicago.

THE origin of this fire seems to have been due to electrical causes, and it is necessary to endeavour to learn from the bitter lessons of experience with a view to lessening the probability of a repetition of such a disaster. The report of the Chicago Underwriters' Association is therefore instructive reading. Quite apart from recommendations and criticisms referring to mechanical details, it is pointed out that the metal casings of lamps ought to be so designed that they cannot become sufficiently hot to ignite combustible material. They also consider that the electric lights for the auditorium should not be controlled from the stage, and that the exits should have red lights placed above them or be otherwise specially illuminated. The report does not appear to throw any substantial blame on the electrical arrangements, but rather points out that the disaster is to be attributed to the wholly defective precautions which had been taken to deal with an unexpected catastrophe. It is certain that the superior character of the building construction created over-confidence, which caused the absolute necessity for proper fire protection to be overlooked.

FOREIGN ITEMS.

Venezuelan Enterprise. Caracas is lighted by power derived from a waterfall 12 miles distant; and several other waterfalls, some of which are 2,000 feet high, are to be developed within the near future.

HOME BREVITIES.

A Motor Load. The Belfast Council has now a motor load of 1,900 h.p., this figure being 50 per cent. in excess of the figure for the preceding year.

Electric Lighting at Foot's Cray. Schemes have been submitted to the ratepayers, at a meeting which was held at the Sidcup Town Hall; but the proposal that the Council should be empowered to proceed did not meet with approval.

The Cost of Gas. The engineers of the Isle of Wight Gas Co. have challenged the electrical engineers to show that they can produce a light in any unit from 30 to 300 c.p., at a cost less than three times that of incandescent gas.

Extensions at Nottingham. The electric light station requires further extensions in consequence of the rapidly increasing demand, and at least £100,000 will have to be spent in the course of a year or so.

School Lighting. Bradford Grammar School has been lighted electrically. The hall has twelve Nernst lamps, each of 220 c.p., and the rest of the buildings has arc and incandescent lamps.

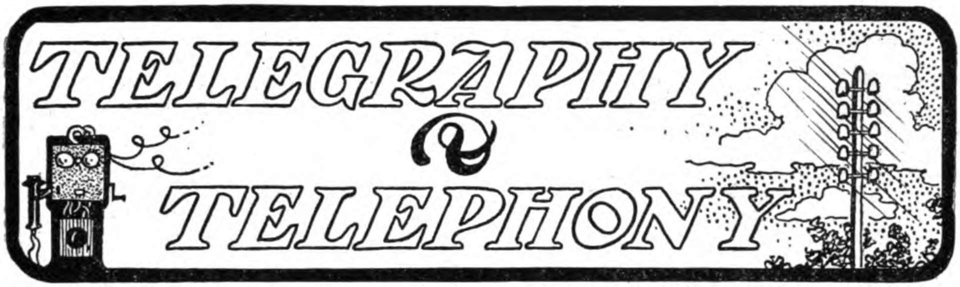
Electric Lighting at Sidcup. Messrs. Mordey & Dawbarn have advised the local Council to take electricity in bulk from the Bexley authorities; but there is some opposition to the adoption of this suggestion.

Dundee Central Station. The old rubber cables have been pulled out of the pipes in which they laid, and are being replaced by fresh cables laid in bitumen in porcelain ducts. Consumers have been advised to scrap all lamps, after they have been used for 700 hours.

Fulham Street Lighting. It is estimated that if Nernst lamps were used, giving 70 or 80 c p., the cost per annum would be £4, with current at 1½d. per unit, and that it would cost £2 15s. to join up each lamp. This system is likely to be worked. Incandescent mantles would cost £3 9s. per annum, together with an initial expenditure of £2 per lamp.

The Miniature Arc. Nernst lamps have a formidable rival in the small arc lamp. One type has a special solenoid to burn on 100-120 volt circuits without a separate resistance. The same lamp is made to burn 2 in series on 200-230 volt circuits with differential mechanism and line resistances. Current consumption is about 2 ampères for 200 c p.

New Arc Lamp Mechanism. We are promised, by ***The Electrical Review***, some important developments in arc lamp construction. Details cannot yet be given, but it is believed that the irreducible minimum has been attained in the number and cost of the working parts. Both carbons are above the arc, and magazines, for automatic renewals, can easily be fitted.



TELEGRAPHY & TELEPHONY

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegraphic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

* * *

A New Metrical Detector for Electric Waves.

L. H. WALTER, M.A., A.M.Inst.C.E. A.M.I.E.E.

ELECTRICAL oscillations have so long been in need of a satisfactory metrical detector, that a description of a new oscillation galvanometer, which the author designed in conjunction with Prof. J. A. Ewing, F.R.S., will probably be of interest. This instrument differs from any detector hitherto invented, in that the oscillations directly and visibly indicate their presence by a mechanical movement proportional to their intensity, as a galvanometer responds to a continuous current, and in that such quantitative readings can be directly obtained over a practically unlimited range without any alteration to the ærial wires or other conducting masses used to pick up the waves. Prof. Fessenden some time ago pointed out the practical impossibility of obtaining a direct mechanical movement from the interaction of the oscillations and a magnetic field, owing to the extremely high frequency of the latter, though quasi-direct effects have been obtained by Huth with his detector. But the sensitiveness obtained by such methods is so low, that their use of wireless telegraph receivers is out of the question, not to mention their sensitiveness to tremor, etc., owing to the delicate suspension. By using an extraneous source (a rotating field) to supply the energy, and making use of the novel property,—discovered by the author—that by passing such oscillations along a magnet wire, itself subjected to a rotating magnetic field, the hysteresis is enormously *increased* (the effect of the oscillations being to permit more of this externally supplied energy to be utilised)—this difficulty is overcome, the same effect being obtained, and to a vastly increased extent, as if the direct electro-dynamic effects of the oscillations were made use of. The instrument depends, as before stated, upon the increase of hysteresis (in the sense of work done per reversal) produced in a bobbin of steel wire, placed in a rotating field, when oscillations are passed through the wire itself, such oscillations producing an oscillatory circular magnetism super-imposed on the varying longitudinal magnetisation. The principle and the preliminary experiments leading up to the design of the present instrument are described in a paper by Dr. Ewing and the author on "A new method of Detecting Electrical Oscillations,"

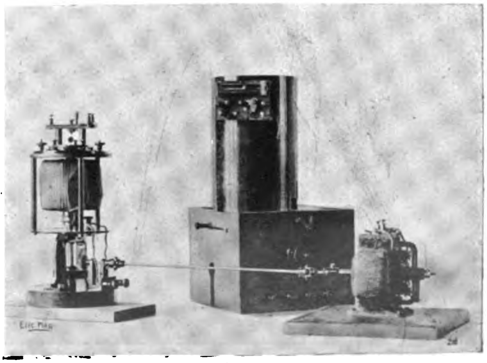


FIG. 1.

read before the Royal Society, Feb. 11th, 1904.

Briefly, the instrument is an adaptation of the Ewing Hysteresis Tester, in this case the specimen being held fast, and the magnetic field revolving, being driven by an electric motor. In Fig. 1 the arrangement is shown in its simplest form, there being a magnet, the poles of which are rotated on an axis, producing the rotating field. The bobbin, which is supported on pivots in jewels, is prevented from following the field by means of a controlling spring. The winding on the bobbin is made as nearly non-inductive as possible by being double wound, and consists of a number of turns of very fine insulated steel wire, the plane of the turns being at right angles to the axis of the bobbin. The bobbin is immersed in petroleum or thicher mineral oil, according to the amount of damping required, the oil also serving to steady the deflection and to improve the insulation. The instrument has to be considered from two standpoints, the requirements of which are somewhat different. Thus, for physical measurements and metrical purposes generally, it is provided with a permanent magnet system for the field, and readings are taken by spot and scale, a mirror being fixed on the bobbin axis. When the apparatus is working, there is a steady deflection, due to the normal hysteresis, and the spot can be set with the zero at any part of the scale. On oscillations arriving, the bobbin gives a throw in the same direction as that due to the normal hysteresis (same direction as the field), returning to the normal position as soon as the oscillations cease.

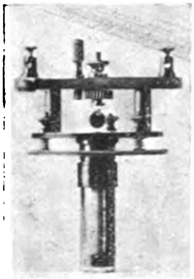


FIG. 2.

The sensibility of the instrument can be made anything desired, firstly, by suitable proportions being given to the bobbin and the wire winding. Thus, for measurements near a spark coil, a very small bobbin and short length of wire of larger diameter and lower resistance will suffice, and such wire can be more highly insulated. For other purposes where a low resistance may be desirable, the instrument can be equipped with a bobbin provided with a copper primary of low resistance (either on the bobbin itself or as a fixture external to it, through which the oscillations are to pass), acting inductively on the magnetic winding, which in such a case must be inductively wound and closed on itself; several modifications of such windings can be seen in the patent specification if desired, so that it is unnecessary here to describe them. An instrument provided with a bobbin of high sensibility (of the order of an average coherer) can, however, be used for such measurements if a shunt circuit is employed.

For a receiver for wireless telegraphy, the requirements are somewhat different; sensitiveness (within limits) and rapidity of action being the dominating requirements. Any type of recording mechanism can be worked by the bobbin, a syphon recorder attachment having been fitted with one instrument. It can, however, also be used as a relay. The oscillations used for this purpose are also of much greater wave-length, necessitating, in the case of simple direct-excitation connection (for the best results), the use of a more considerable length of wire on the bobbin. When using a transformer or a shunt connection the conditions are different. The author hopes shortly to be able to publish the results of experiments in this connection. The Figures show one type of the instrument in which an electro-magnet furnishes the revolving field. In Fig. 1, the outer covers are removed to show the magnet system and the interior of the motor box, and in Fig. 2, the bobbin is shown in its cell.

A RECENT INTERESTING PAPER.

DR. J. E. IVES, in an article on the "Wave length of Free Vibrations in Autennal and Closed Oscillatory Circuits," publishes the results of a series of experiments made at the request of the de Forest Wireless Telegraph Co., at their Castleton Hotel Station on Staten Island, in the Bay of New York. Results are not often published of experiments in practical wireless telegraphy, at any rate to be of assistance, so that we can welcome this paper giving numerical results, enabling the experiments to be repeated if necessary. Dr. Ives promises to describe in a later article in *The Electrical World*, the instrument with which the measurements were made, and the method employed to calibrate it. The paper first shows the effect of inserting a variable number of turns of an inductance coil, in helix form, 1 ft. diameter with 21 turns of No. 14 wire, the turns being one inch apart. The antenna, 62 ft. long, consisted of two No. 14 wires a foot apart, connected through the helix to an earth-wire, 27 ft. long, itself connected to an earth-plate. The total length from tip of antenna to earth-plate

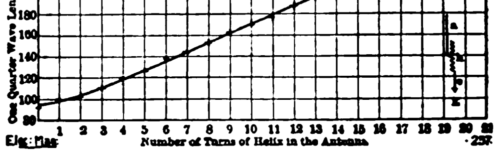


FIG. 1.

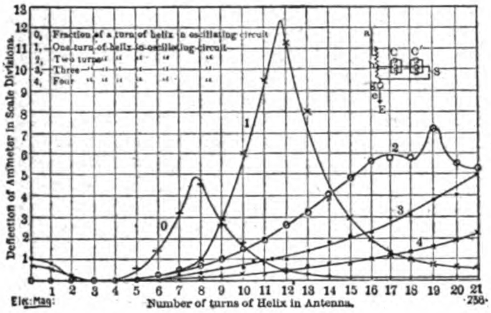


FIG 2.

was thus 89 feet (see Fig. 1). The curve obtained is nearly a straight line, which was to be expected, from the fact that the wave-length varies as the square root of the inductance, and the inductance varies as the square of the number of turns, the capacity for a given aerial being practically constant. A similar curve is obtained with a closed circuit, but the values here vary irregularly from one side of a straight line to the other. The effect of increasing capacity in the closed circuit is shown in a curve which is parabolic in form. The most instructive curve is that showing the resonance of the antenna with the oscillating circuit (see Fig. 2). Here antenna and closed circuit are linked together, so that the helix has some turns common to both. The spark-gap is in the closed circuit. The well marked maximum shows the increase in current in the antenna (measured by a hot-wire ammeter g), when that is brought into resonance with the closed oscillating circuit. The experiment was made by putting a certain number of turns on the helix in the closed circuit, and then altering the number of turns in the antenna. Five sets of readings were made, giving the five curves shown in the figure. A number of useful curves are also given showing from the calculated values the relation between the inductance of a wire and its diameter, and the inductance of a circle of wire and the diameter of the circle.

THE TREND OF MODERN WIRELESS.

WIRELESS Telegraphy, like all new developments, progresses in well defined stages. There is a burst of activity following a new or important result, a gradual calming down, a period of quiet, to be followed, after some further new result, by another spurt. There was the coherer stage; the tuning stage, which was *not* tuning; the current-actuated receiver stage, and the weeding-out stage. The wave-directing stage appears to be the most recent arrival. The methods suggested by Prof. Artom, Prof. Braun and Mr. S. G. Brown respectively, have recently been described, but, from patents recently issued to him in the U.S.A., Dr. de Forest has also been working in this direction. In one of these, he uses a reflecting arrangement for the waves (resembling somewhat the method of Braun), consisting of a series of aërial wires surrounding the transmitting aërial wire, which latter is placed in the focus of the reflecting wires, but an arrangement is here also provided for reducing the necessary distance between the transmitter and the reflector by including lag producing devices. The other patent, which is also for concentrating and imparting direction to the waves, involves a much simpler construction than that just described. It consists in employing at the transmitter a horizontal as well as a vertical wire, the horizontal one, B, being extended in the direction in which it is desired to communicate. The horizontal wire is insulated and led off from the base of the vertical wire, A, which is, as usual, one quarter wave length long, the horizontal one measuring one half wave-length. The far end is grounded through a spark-gap, as at B. By this arrangement the vertical and horizontal wires are charged oppositely before the spark occurs, and as the lines of force lie mainly in the plane of the two conductors, the waves have a direction of propagation imparted to them, as well as being concentrated somewhat in that direction.

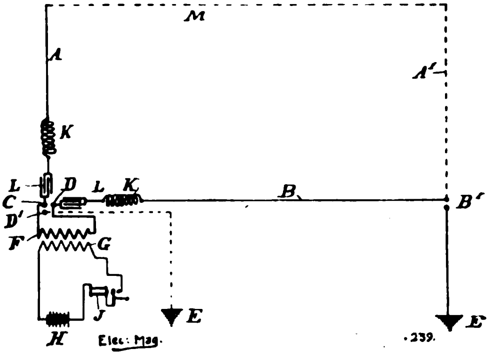


DIAGRAM OF CONNECTIONS.

At the other end it is preferred to receive with two aërials and to place the responder at a point where it is subjected to two potential maxima of opposite sign.

THE NEW POST OFFICE TRUNK SWITCHBOARD.

AN interesting event in the history of telephony is the opening of the new trunk switchboard in the Post Office, London. Hitherto, the trunking operations have been carried on at the Central Telegraph Office, St. Martins le Grand, but the demand for more space rendered a transfer to the new switchroom at Carter Lane necessary. The new switchboard consists, generally, of three sections: ordinary, concentration, and transfer. To the ordinary section, five trunk lines are connected during the busy hours of the day, constituting one operator's position. Two of these positions are controlled by one operator during the less busy hours of the day, while at night and on Sundays, arrangements are made on the concentration sections, whereby trunk wires from 5 upwards can be operated. The transfer sections are employed for connecting distant towns together. Three record tables are used for receiving and booking the trunk calls from the subscribers. Each table is equipped with 20 lines, and is attended by one or two operators, according to the traffic.

Provision is also made in the subsidiary sections for subscribers renting special trunk lines, foreign lines, *viz.*, to France and Belgium, and a learner's section for training purposes. In addition, the necessary test boards, intermediate distributing frame, relay and condenser racks are fitted in a separate room, while the power plant is erected in the basement. The framemork of the board is built of angle iron, while sheets of uralite are extensively used as a protection against fire. The wires carrying the heavier currents are arranged in an iron trough on the top of the board. The trunk cables and transfer wires are contained in a trough in the floor level, amply protected from fire. The front of the board is of polished mahogany, the whole appearance being exceedingly substantial and elegant. Lamps operated by relays are employed throughout for signalling purposes.

The apparatus was constructed by The British Insulated & Helsby Cables, Ltd. Anyone privileged to examine this latest telephone production will recognise that British manufacturers are capable of successfully competing, both in finish and excellence of workmanship, with foreign manufacturers.

HOW IS THE TELEPHONE PROBLEM TO BE SOLVED.

It may not be generally known that on the 31st December of this year, the Post Office can, by giving the National Telephone Company six months' previous notice, purchase the company at a price fixed by arbitration. So far no outward signs are apparent in this direction, and probably the Government, having sufficient on its hands, proposes to let the question "slide," and trust to luck for a settlement of the question on the expiry of the license in 1911. A simple solution of the difficulty would be for the Government to leave the telephones alone, and delegate the licensing powers to local authorities. This would give rise to the following conditions :—

(1) The local authorities would be free to arrange a purchase of the Company's local plants and conduct the telephones as municipal undertakings.

(2) The local authorities could, failing a satisfactory settlement of purchase, lay down an entire fresh and up-to-date plant.

(3) The local authorities could grant a license to the Company for a period of years subject to arrangements respecting rates, way-leaves, service, purchase, etc. The prolongation of the life of the Company would assist in extricating it from its difficulties, while at the same time it would afford those local authorities, whose hands are at present filled with work, ample time to develop and consolidate their present undertakings before embarking on a telephone enterprise.

This would relieve the Government, present and future, of the solution of a most difficult problem. It would enable the Company to extend its business in perhaps the greater portion of the country, while to progressive municipalities one more remunerative undertaking would be available for development.

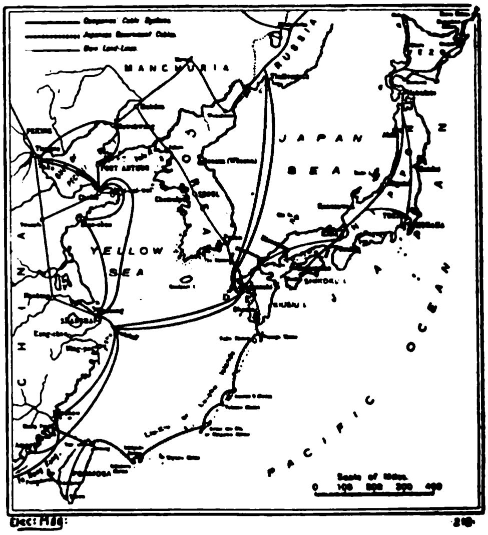
THE WORLD'S SUBMARINE CABLES.

According to the publications of the Bureau International, at Berne, it would appear that since 1901 there has been an enormous extension of the world's submarine cables, totalling 30,000 miles. Comprised in this large aggregate are the cables of the Commercial Pacific Company, having a gross length of 7,840 miles between San Francisco and the Philippine Islands, with coast cables of those islands extending to 1,314 miles in all. Further additions to the list are the French cables, Oran to Tangier and Toubine to Amoy, 2,772 miles; the German Transatlantic, 1,952 miles; the British Post Office, 238 miles; the Eastern Telegraph Company, 164 miles; Russia, 171 miles; the Indo-European Department, 216 miles, from Jask to Muscat; the Dutch East Indies, from Java to Borneo and the Celebes, 972 miles; Japan, 131 miles; the Eastern Extension Telegraph Company, from Mauritius *viâ* the Cocos Islands to Australia, 5,400 miles; and the Commercial Cable Company's duplicate cable from Waterville to Bristol, and a new cable from Waterville to the Azores, in all, 1,550 miles.

RUSSO-JAPAN WAR.

The Cable Communications.

It is not unlikely that the cables on the China and Japan coasts may be cut by Russia during the present war, and, to guard against the isolation of Japan from telegraphic communicaton, the United States Government has sanctioned the connection by cable of a point on the coast of Japan with Guam, to join the Commercial Pacific Cable. The cables from Vladivostock to Nagasaki, of the Great Northern Company, have been closed to traffic by the Russian authorities. Already, it is reported, a Russian cruiser has been at work grappling for cables on the north-west coast of Japan. The latter country possesses, however, a repairing steamer, which could operate under the protection of naval guns, so that it is possible that means may be found to prevent all communications from being cut off. The accompanying map, published by the *Electrician*, will be of interest in exhibiting at a glance the existing cables.



Existing Cables in Japan.
(By kind permission of "The Electrician).

TELEGRAPH NOTES.

Telegraphic Work in the Baltimore Fire.

Some very smart practice in restoring communication was exhibited in Baltimore during the late conflagration. The Postal Telegraphic Cable Company had its main office on the twelfth floor of a steel skyscraper which was threatened with destruction about 7 p.m. All wires were then in preparation for a main connected through in the subway terminal room in the basement. Records and apparatus were hurriedly packed and at 9.15 p.m., the building having caught fire, the staff were just in time to escape uninjured. The rain of fire was so intense that some of the apparatus had to be abandoned on the door-step. Temporary quarters were then secured near the terminal poles where the cables and aërial lines are connected in the Northern and Southern sections of the city, and business was re-commenced before midnight. New York being apprised, the first morning train brought a portable quadruplex telegraph plant, consisting of an engine, dynamo, switchboard, motor transformers and quadruplexes in cases ready for use a few minutes after arrival. By 6 p.m. the apparatus was operating in a new head-quarters in North Cabinet Street, and by the following morning a commissariat had been established for all employees, and connections made to the underground cables. Those in the basement of the old building were still on fire, and failed about ten hours after commencement of the conflagration but were restored later. The local Post Office had escaped destruction, and many telegrams which could not otherwise reach the addresses were delivered at this office to those who called. Card indexes were promptly started to record new and temporary addresses, and use was made of transparent covers by means of which the address of a telegram could be read through, the usual superscription being obviated. The work done by the entire force elicited the highest commendation.

The Post Office Underground Cables.

It will be within the recollection of our readers that between the years 1897 and 1900 the engineering staff of the British Post Office was engaged in laying underground paper-insulated and lead-covered cables between London and Birmingham, the usefulness of which was demonstrated soon after the completion of the work, when a violent storm interrupted the overhead lines. Consequent upon the serious inconvenience caused by the failure of communication, on this occasion, between London and provincial towns, the extension of the underground system was urged upon the Government. The cable, soon to be completed into Warrington from Birmingham, contains 103 wires, and is drawn into 3 in. cast iron pipes. At Warrington the lines connecting Liverpool and Manchester can be tapped, and these two cities will then be in underground communication with London. It is expected that Warrington will, before long, be connected in the same way with Carlisle. The line of pipes is now laid continuously from London to Carlisle, and a section of nineteen miles is being laid over the Beattock Summit. Within a couple of months a double line will run underground from Manchester to Leeds. The cost will, no doubt, be heavy, but the convenience to the public will be immense.

A New Gutta Percha.

With the limited supply of gutta percha there has for many years past naturally been keen investigations for substitutes. Nothing hitherto put forth has satisfied the requirements of submarine cables. With gutta percha at eight shillings per pound the advent of a compound, called "Gutta Gentzsch," has caused much interest. Originating in Austria, it is now being produced at a factory in Greenwich, and from the details given in our contemporary, *The Electrical Review*, the material has withstood severe tests during the past four years. The German post-office has found it satisfactory for submarine work, and a bold experiment in this direction is worthy of imitation. The inventor, Adolx Gentzsch, has taken out patents in Europe and America for his material, and it is likely now to be in demand. The journal from which we are quoting states that the dielectric resistance is equal to that of natural gutta, but that the softening point is higher, that is 100° in the one case and 130° in the other; the capacity after submersion of a cable rises gradually and then becomes constant to a degree somewhat equal to gutta percha. The specific gravity is almost that of water. The material cools more quickly than gutta percha. The British post-office is testing the new gutta, and the Danish government has invited tenders for submarine telephone cables insulated with this substance. Its price is lower than that of gutta percha, which will render its introduction the more acceptable.

The Baudot Apparatus.

Pierre Picard has lately adapted the Baudot apparatus for use on the Marseilles-Algiers cables. He has, of course, had to overcome the difficulty presented by retardation. His receiving relay consists of a suspended bobbin similar to that of the syphon recorder, moving in a strong permanent magnetic field and carrying an arm for the necessary local contacts. The transmission of positive and negative impulses is effected by momentary contacts, and the discharge of the cable intermediately is not permitted. The double Baudot is caused to revolve at 180 turns, and has 12 contacts. Picard has provided for "correction" by alloting two segments, one fixed and the other movable, for this purpose, to overcome the effect of irregularities in the peculiar circuit with which he has had to deal. A speed of 40 words per minute can be obtained, with the advantage of a typed slip at the receiving station.

Telegraphs and the Thibet Expedition.

For the service of the expedition to Thibet, a telegraph line has been erected from Darjeeling to Khamberjang, a distance of about 160 miles. The difficulties of construction have been great, owing to the severity of the climate and the ruggedness of the country. The line attains an altitude of over 16,000 ft. above sea level. No doubt it will be carried further, as the experience gained in constructing the telegraph line to Gilgit, in Kashmir, has made it possible to provide against avalanches and heavy falls of snow. It is hardly likely that a permanent line will be built into Thibet, and the present one is probably to serve for the needs of the expedition only.

The Telescripter.

Siemens and Halske's "Telescripter" is in use in Berlin, in connection with a central exchange, bringing one hundred subscribers into communication. The transmitter is a keyboard for letters, figures, and has two keys for capital letters for shifting, and figures and punctuation. The apparatus is similar at each end of a line, and both sets are automatically and simultaneously operated as soon as the blank or starting key is struck. If the owner of the apparatus be absent, the telegram may be read on the paper ribbon, the instrument being stopped automatically at the termination of a message. The operating current is derived from accumulators at 12 volts, and the electromotive force is thus low enough to obviate disturbance in neighbouring telephone circuits, and the line wires may be included in cables with telephone lines.

Telegraph Printers.

To the number of printing telegraph instruments must be added that of Phelps, devised in New Jersey. He has arranged to make the instrument self-winding by sending pulsatory currents by an auxiliary line periodically connected to a commutator. This line is also employed for shifting the type-wheels by current reversals. The spring winding apparatus is driven by a neutral magnet under the action of pulsatory currents, while the press shifting apparatus is actuated by the armature of a polarised magnet set in one direction or the other, according to the polarity of the current flowing.

"Seeing by Wire."

In addition to Edison, who has been at work upon apparatus for transmitting images or pictures by wire, Jan Szczepanik, a Pole, has been elaborating a similar device which, by the aid of lenses and discs, has, it is said, made it possible to transmit the image of an object a distance of two miles. This took place in Vienna, and yet another inventor, Maximilian Plessna, a German, has shown promise of doing the same thing in Paris. Some maker of dictionaries in the future will cross out "space" and "distance" and "invisible" as words without a meaning, and the brotherhood of man will have come through science.

Telegraph Exchanges.

There is little doubt that all large central telegraph offices will adopt the "Switching System" within a few years. Brussels has followed the example of some other cities, and as a result of the introduction of a switchboard on the telephone plan has reduced the number of telegraph instruments from 121 to 53. At the board there are indicators for calling and for ringing off, and while any two telegraph offices are in communication warning lamps were illuminated. When a call is received by the central from a suburban or out-station the operator at the panel where the call is received tests whether the desired circuit is free. This is done by inserting one of a pair of plugs part way into the jack, which movement, if the line is free, causes a relay to come into action and to ring a bell. Having proceeded so far the plug is thrust home and connection given as in telephone working. The system is not only highly convenient, but secures the highest economy in the staff, since there need be few intervals when operators are unemployed.

TELEPHONE CALLS.

London.—The Post Office system continues to make satisfactory progress. Nine exchanges, including 15,020 stations, have been opened. More capital will shortly be required for further development.

Scarborough.—The Town Council is now showing signs of activity in the direction of municipal telephones. A report is being prepared for the Council of the progress and extent of the telephone undertakings by local authorities elsewhere.

Toledo, Ohio.—A proposal has been made by the Telephone Company to raise its rates, owing to the development of the system being much in excess of the number on which the original rates were calculated.

Swansea has almost completed arrangements for intercommunication with the National Telephone Co.'s service. The demand for telephones has been so great that sanction for further borrowing powers will shortly be asked.

Bournemouth.—The Town Council are arranging with the International Electric Co. to undertake the installation and working of a system of telephones. The rates proposed are £6 for unlimited use, with varying rates for subsidiary services. There is no reason why this experiment should not be a success. It will be watched with interest throughout the country.

WIRELESS WAVES.

An Offshoot. The Department of Agriculture, U.S.A., has, according to *The Electrical World* perfected a new wireless telegraph system of its own. It differs from the Marconi and de Forest systems, but particulars are lacking. The system is now in successful operation between San Francisco and the Fallaroues Islands, a distant of 27 miles.

Thawing Frozen Aerials. The electric tramcar must look to its laurels. It no longer, apparently, is to have the monopoly of sleet-cutting machines and devices for thawing ice (off the rails). A patent recently issued to Dr. de Forest, is for a method of freeing the aërial wire from sleet and ice: a dynamo of considerable amperage being used, and connected to two sets of aërial wires coupled at their upper ends.

Wireless at St. Louis Exhibition. Wireless Telegraphy will be well represented at the forthcoming St. Louis Exhibition. The de Forest Co. is erecting a tower as a wireless station. It is to be 350 ft. high and a mast 250 ft. high will be erected beside it. The power plant will include a 90 kilowatt transformer. It is expected to be able to communicate with Chicago over 300 miles distant, as well as with the surrounding towns.

Mexican Developments. The Mexican Government has, according to the *Elektrotechnischer Anzeiger*, recently ordered two wireless telegraph stations from the Drahtlose Telegraphie Gesellechaft, who use the Telefunken system, better known as the Braun-Slaby-Arco. The stations are for communication between Cape Haro and Santa Rosalio across the Gulf of California. It is the intention of the Mexican authorities to establish a chain of such stations along the Gulf.

Wireless Scores in Brazil. Satisfactory experiments with a wireless telegraph system between Manaos and Iquitos have resulted in the Cable Company buying the right to use the system between Para and Manaos. With a cable line it has been found almost impossible to continue steady operation, as the present cable, recently laid at great expense, is rarely in working order more than one or two days a week.

Damaged Stations. The Marconi station at Antivari, Montenegro, erected for communicating with Bari on the Italian coast, some 90 miles distant, has been destroyed by a violent hurricane, the instrument shed and the aërial erection being, according to *l'Elettricita*, completely wrecked. This, with the damage to the Admiralty aërial at Dover recently, shows that such structures are evidently not fitted for exceptional strains; their life has not been long enough to attribute the weakness to decay of material.

German Enterprise. There is now a wireless service between North Germany and Denmark. The stations at Bülk, near Kiel, and on the Island of Fehmarn respectively, using the Slaby-Arco system. Private messages are accepted. The charge is 80 pf. per message, irrespective of the number of words, and for an extra 5 pf. per word to any part of Germany or Denmark. A German steamship line, whose vessels run between Kiel and Korsoer, have also wireless installations, and can communicate with land throughout the passage.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable; that coal may absolutely be removed from the ranks of necessary commodities; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

Electro-Chemical Industries.

By H. BORNS, Ph.D.

WHILE a few years ago some electro-chemists liked to present us with diagrams indicating the branches of chemistry and metallurgy not yet occupied by electro-chemistry, writers on the progress of electro-chemistry have now to admit that most of those blank spaces remain blank, that a few more spaces have become blank, and that the metallurgy of the future, the electro-metallurgy, is still to come. It may never come. To make that admission does not signify at all that applied electro-chemistry has proved a failure. Electro-chemists can point to many very important achievements, and metallurgists may indeed regard them as somewhat impatient. Their own processes have been worked out by generations of practical men, and if it were not for the astounding development of electricity, electro-chemists and the general public would scarcely have looked forward to an early replacement of the old-established methods. It has taken half-a-century to make the catalytic sulphuric acid process a success, and many a chemical process on which electro-chemists try their skill, stands less in need of improvement than the old lead chamber process did. Old and new methods should supplement one another.

Electro-chemical industries can, moreover, hardly be expected to be particulary prosperous when neither of the parent industries enjoy conspicuous prosperity. That the United Kingdom does not lead in electro-chemical enterprise is often ascribed to the want of water power. Water power has, however, little to do with the question. Hydro-electric stations originated in the Alps; but neither the Swiss nor the French electro-chemical works pay more than average dividends. Where water is cheap, transport is, as a rule, expensive. With the complications of a power distribution over large areas for various purposes, and the necessity of providing a steam reserve, the cheapness of the primary source of power becomes a secondary factor. Even at Niagara, where there are no transport difficulties, water power cannot be obtained on exceptionally low terms. The Dow Chemical Works (electrolytic bleach) of Midland, situated on the Saginaw coal fields of Michigan, at any rate seem to produce their steam power as cheaply as it could be had from waterfalls. The usual statements concerning the power used by the electro-chemical plants are, moreover, not very reliable. If it is projected to utilise thousands of horse power in a new factory, those thousands will continue to figure in statistics, although the hundreds started with are not supplemented. Nor is the power item the chief item in the finances of electro-chemical manufacture.

The public still seems to nurse a kind of fancy that the electric current will always do what we want it to do, and refrain from doing what we do not wish. The charming simplicity of the electrolysis of certain pure solutions fosters the belief that we should be able to manage other and impure solutions on similar lines. Though galvanoplastic processes are the oldest examples of applied electro-chemistry, we do not fully understand even now how metals are deposited, and why we are so often troubled with spongy, non-coherent deposits. We are told that secondary deposits are preferable to primary deposits; but authorities differ as to whether silver is primarily or secondarily deposited from cyanide solutions. The literature on the electrolysis of alkali chlorides would fill a good many stout volumes, and the authors generally require a few columns to sum up the results and conclusions arrived at. In the important electrolytic reductions, especially of organic compounds, the kathode material, whether platinum, mercury, copper, etc., and the conditions of its surface, exert an influence which is now fully recognised, but not quite explained. To set hydrogen free requires a certain tension—the over-voltage of Caspari and Nernst—above the decomposition tension, and the position of the hydrogen in the voltaic series changes with that tension. Chemists now perform a considerable number of oxidations, reductions, and synthetical processes with the aid of the electric current. But since the current is only applied at a particular stage of a series of reactions, and as chemists do not take the public into their confidence, we here little of these applications.

The perfection of electric laboratory furnaces by Heraeus and others has helped us to quartz crucibles and quartz vessels. White hot quartz may be dropped into cold water, and many experiments may be risked with quartz vessels, which glass would not stand; but the quartz must not come in contact with oxides. Most electric furnaces are current wasters like the ordinary fnrnaces; W. Hempel has, however, constructed simple and convenient furnaces by joining carbon rods to a zigzag. For technical furnaces, J. W. Richards has calculated a maximum efficiency of 75 per cent., but we certainly do not realise anything like that figure as a rule. The calcium carbide industry cannot be called flourishing, but it is improving. The Union Carbide Co. (Horry furnaces) manufactures only at Niagara Falls; the great 15,000 horse power plant at Sault Ste. Marie, about which so much has been written, remained incomplete last year. The continental carbide works, upon which plenty of money has been spent, are still having a struggle, and it may be mentioned as a rather peculiar illustration of the intricacies of protective duties that Germany exported only 126 tons of carbide in 1902, and imported 11,287 tons. American carbide prices make exports from there profitable.

Acheson's graphite electrodes and his carborundum (carbon silicate) prepared in electric furnaces, are doing well; the graphite electrodes enjoy high favour. The by-products of the carborundum furnace, known as white stuff and ciloxicon, are recommended as refractory materials. Siloxicon, a compound of carbon, silicon, and oxygen, was first described as indestructible, but it decomposes in atmospheres containing oxygen, above 2,675 deg. Fahr. Barium hydrate has for some time been prepared from natural sulphate in the electric furnaces of C. S. Bradley, Jacobs, and Read; the process does not seem to offer sufficient advantages over the old furnace process.

The electro-metallury of iron, which was received with much scepticism, seems to have successfully emerged from the experimental stage. Stassano, in Italy, is generally credited with having been the first who melted iron ore—superior Italian ore—in an electric furnace, and with having thus produced a good iron; but Héroult may have anticipated him. In the Stassano furnace, the arc plays above the iron and flux, and the current is regulated more or less automatically. Similar arrangements have been adopted by Conley, Harmet, Keller, Gin and Leleux, and others, several of whom separate the iron furnace from the steel furnace. This is also done by Héroult at La Praz in Savoy, and in Swedèn; in rocking Wellman furnace Héroult has already produced about 1,500 tons of good crucible steel. Kjellin in Gysinge makes real tool steel on a different plan. He places the iron ore in an annular groove lined with quartz or magnesia, and heats it indirectly by the aid of a high tension transformer which surrounds part of the groove; there are no electrodes, therefore, and contamination of the iron through them is impossible. Schneider, in Creusot, similarly applies indirect heat with the aid of a revolving system of electromagnets. Ruthenburg, in Lockport, N.Y., melts fine magnetite grains in the narrow gap between the cooled slowly rotating poles of an electro-magnet; the melting ore loses its magnetism, and drops into a pit through which reducing gases are passed. The reduction takes place at a low temperature.

Alloys of the heavier metals, ferro manganese, ferro chromium, silicides, titanides, etc., are made by several of the carbide works, by Simon in Orlu, by the Cowles Aluminium and Smelting Co., at Lockport, the Ajax Metal Co., of Philadelphia, and by many others.

Most of what is known about the Hall process of the Pittsburg Reduction Company has leaked out during the patent litigations between this company and the Cowles Company; the question has not been carried before the highest U.S. Court yet. Haber and

Geipert's experiments on aluminium furnaces have also given rise to an instructive discussion. That we have cheap aluminium, we owe, of course, entirely to the electric furnace. Electric glass smelting is practised at Deutsch Matrei and in St. Gobain; the Société de l'Industrie Verrière is also experimenting in this field.

Concerning the oldest and most thriving electro-metallurgical industry, electrolytic copper refining, the communications brought by Bancroft, Baum, Schwab, Hofmann, McA. Johnson, and others, before the meetings of the American Electro-Chemical Society, held in 1903 at New York and Niagara Falls, and also Haber's report on the American electro-chemical industry, have directly and indirectly supplied a good deal of information. About 86 per cent. of the copper of the world is refined in the United States, and 9 per cent. in Great Britain. Both the multiple and the series system have their advantages, but it would be useless to enter into these questions in a brief article; vast interests are concerned, as everybody knows.

The extraction of copper ores and the separation of the metal with the aid of sulphur dioxide has again been proposed by Gin and by Tossizza, and introduced by Neil in Arizona, and by Carmichael in Dorchester, Canada. Gold ores are in Dale, California, extracted with ammoniacal cyanide solution after Hunt's process. Most direct electro-metallurgical processes have proved disappointing, however. The Pélatan-Clerici process of combined gold extraction and deposition in a kind of Hungarian mill seems to have been abandoned. The extraction of sulphidic zinc ores with sulphuric acid has not given satisfaction either. But the Swinburne-Ashcroft process, which has entered upon its technical stage, aims, as Mr. Swinburne expressed it before the Faraday Society—the society of British electro-chemists established last summer—"at nothing less than a revolution of the major part of metallurgy." By regulating the temperature and the feed in furnaces (called transformers) of proper dimensions, the inventors decompose the sulphides by dry, cold chlorine gas, introduced from below through carbon nozzles, so that chlorides and in addition free sulphur—not an objectionable sulphur chloride—result. The chlorides are then separated in various ways, and the fused zinc chloride is finally electrolysed. A successful issue of these long-continued able experiments with Broken Hill ores would indeed constitute great progress; the recovery of the sulphur is alone an important improvement.

As regards nickel ores, the D. H. Browne process of the Canadian Copper Co. seems likely to supplant the attempts of Höpfner, Frasch, Ulke, and others, although the formation of the International Nickel Trust, which also controls the old Orford process, has altered the position. Browne roasts the ore, reduces it with coal, and casts half of the matte into anodes, while the other half is converted into shot; the lye consists of the chlorides of sodium, nickel, and copper; most of the copper is deposited, the rest chemically precipitated, the nickel solution oxidised to remove the iron, passed through the evaporator in which sodium chloride is allowed to crystallise, and finally electrolysed. A pure nickel is said to be produced. The processes for treating poor sulphidic ores, worked out by Borchers, Rontschewsky, Dorsemagen, and Kügelgen, by Günther, and by others, have several features in common with the Browne and earlier processes.

Whether Salom (and the late Weightman), of The Lead Reduction Co., of Niagara, will obtain a purer lead by the electrolysis of ground galena in their trough-shaped cells, after having adopted very slowly revolving kathodes, remains to be seen; with the original arrangement the hydrogen carried particles of undecomposed galena into the deposited lead, thereby rendering it impure. More is expected of Betts' very promising lead deposition process. Betts, in Trail, British Columbia, dissolves anodes of lead bullion in hydrofluo-silicic acid, obtained from commercial hydrofluoric acid and quartz, which seems to furnish an excellent electrolyte; his lead is described as very pure.

Coming to the manufacture of the alkalies and chlorine, we are in England reduced to two processes, those of the Castner-Kellner Co., of Weston Point, and of the Electrolytic Alkali Co., of Middlewich (Hargreaves-Bird). In Germany we find the Griesheim-Elektron process, the oldest in existence, the Solvay process, and the Bell process of the Oesterreichische Verein; in France the Cie. Générale d'Electrochimie; in Switzerland the Société des Produits Chimiques; in the United States the Castner Electrolytic Alkali, and the Acker Company, both of Niagara. This list of processes and companies is not complete. But some electrolytic alkali companies, *e.g.*, the Rhodin Works at Sault Ste. Marie, and the Roberts Chemical Co., of Niagara, have, temporarily at least, dropped out. Acker proceeds on the lines of Hulin. The alkali chloride is fused with a lead cathode, the lead sodium alloy atomised by steam, and a practically anhydrous caustic soda obtained, besides free chlorine, which at first caused serious trouble. The graphite anodes are said to answer well, just as they do in the Browne nickel process where they have lasted years: it is only in sulphate solutions that they fail. New investigations in the electrolytic preparations of chlorates have been published by Brochet and Ranson, Oechsli, Tommasi, and others. Most of our chlorates, and also a large proportion of the bleach chlorine are now made electrolytically. The Niagara Electro-Chemical

Co. makes sodium after Castner, as is done in this country and on the Continent. It is noteworthy that the recent researches of Leblanc and Brode on the electrolysis of fused caustic alkalies bring out peculiar differences between potassium and sodium. For the electrolysis of aqueous solutions of alkali chlorides, Forester and E. Müller, Chilosetti and Denso, would, however, on the whole, prefer platinum-iridium electrodes. The Dow Chemical Co., of Midland, Michigan, the chief American bleach manufacturers, use diaphragms of the hydrates of iron, magnesia, and lime. The American Electrolytic Co. applies a diaphragm cell, of the Hargreaves type, the Warren Paper Pulp Co. the Carmichael process, the new works of the Italian Electrochemical Co. Chalandre-Golas cells. Bernfeld has introduced new asbestos diaphragms, which are made more durable by a heating process.

Ozone has of late again been utilised for the purification of potable water, notably by Siemens and Halske, at Wiesbaden and Paderborn, and by Vosmaer and Lebret at Schiedam. Apparatus for the electrolytic preparation of hydrogen and oxygen (generally from caustic potash), are made by several well known firms. Passing over the by no means unimportant preparation of various chemical compounds, chromates, permanganates, peroxides, lead white, etc., etc., the fixation of the atmospheric nitrogen deserves notice. It has been attempted in various ways. Regardless of the fact which G. Beilby pointed out at the Berlin International Congress for Applied Chemistry last summer, that the actual cyanide works of various descriptions could supply more than twice the 5,500 tons of cyanide wanted annually—excepting America—many chemists and electricians have endeavoured to produce cyanide in the electric furnace with the aid of carbides. The calcium cyanide which Caro and Frank have thus produced directly from lime, coal, and nitrogen, has proved a good manure, and so far it seems that the nitric acid process of C. S. Bradley and Lovejoy is more likely to give us a mixture of nitrate and nitrite, valuable as manure, and possibly for further treatment, than nitric acid. That some nitric acid is produced by sparking in the air, has long been known; the researches of Rayleigh, and more recently of MacDougall and Howles, Kowalski, Volney, and others, are not very encouraging, however. Muthmann and Hofer found working under pressure advantageous; von Lepel has tried continuous currents, while the others prefer high tension alternating currents. Lovejoy and Bradley, in Niagara Falls, use a multiple contact wheel which produces 400,000 sparks of very weak current intensity, but high potential, per minute. Another method of preparing nitric acid, namely, by the electrolysis of fused nitre on Darling's plan, has been abandoned after continued trials by Harrison Bros. in Philadelphia.

The manufacture of carbon bisulphide in the electric furnace from sulphur and coal, has, on the other hand, been made a decided success by E. R. Taylor, in Penn Yan, New York. In the new furnace which he is now building, anthracite is to be applied instead of charcoal. The sulphur comes from Sicily, and it is not uninteresting in connection with this manufacture that H. Frasch has succeeded in bringing the sulphur up from its natural beds in Ohio and Louisiana by forcing water of 163 deg. Cent. and compressed air down a system of concentric pipes. Two other novelties of minor importance may show that something may be achieved by simple electrolytic processes. Count Schwerin clears suspensions and forces most of the water out of wet peat by electric osmosis; the water collects as a rule at the cathode, and the process is said to be cheaper than evaporation. W. von Bolton and Siemens and Halske dip lamp carbon rods as anodes of an ordinary 110 volt circuit for a few seconds into sulphuric acid; the carbon at once becomes bright and polished.

To sum up, the general outlook of applied electro-chemistry cannot be called bright perhaps. But every industry has to struggle in our days, and we might with equal justification remark that, though electro-chemistry has not so much simplified chemical processes as was expected, it has certainly opened up new ground, and affords the chemist valuable help in many and different ways. The analyst, for instance, finds electrolytic methods very convenient, and our old familiar galvanic processes, to which I have not referred, have greatly profited from the general advance in electro-chemical science.

A NEW PROCESS FOR WELDING ALUMINIUM.

The apparatus illustrated below, though not actuated by the agency of electricity, will be of interest to our readers, in that the welding of aluminium, a metal produced in the electric furnace, is described.—[Ed.]

The Cowper-Coles process for welding aluminium requires no flux, and does not necessitate the hammering of the joint when in a semi-fluid state. The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded, after being faced off square, in a machine (Fig. 2) fitted with clamping screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers, D. The aluminium to be welded is heated by means of an

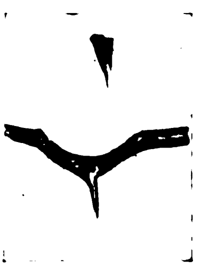


Fig. 1.

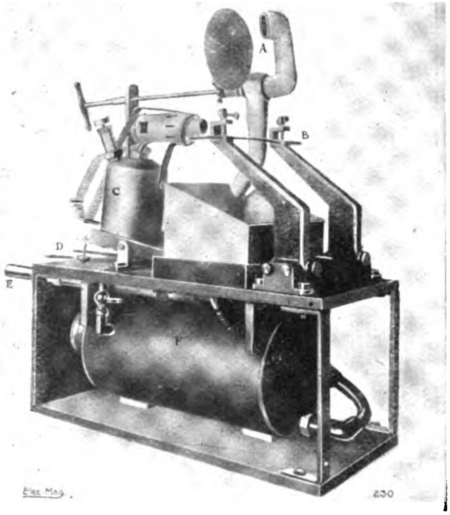


Fig. 2.

ordinary benzine lamp. As soon as the rods have arrived at the necessary temperature, slight pressure is applied to the levers, D, which causes the aluminium rods to unite, and a ring of metal is squeezed out. This ring is largely composed of aluminium oxide, and acts as an insulating and supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle attached to the screen, A, which allows water, under pressure, to be projected on to the joint from the reservoir, F. The same handle, which turns the water on, places a screen, A, in front of the heating flame; the water pressure is maintained by air supplied by the hand pump, E. The rod is finally removed from the machine and the collar filed off, when it will be found that the joint is as strong as the rest of the metal. An oxygen-hydrogen flame or ordinary gas, with or without air, is substituted for the benzine lamp. The process is a simple one, and can be worked by any unskilled workman. Fig. 1 clearly shows the molten aluminium supported by a pipe or case of aluminium oxide, the case having been pricked with a steel point to allow some of the molten metal to flow out. The table shown below gives the result of tests for tensile strength on twelve consecutive welds (not picked specimens) made by the process just described. The fractures occurred at a considerable distance from the weld, showing that the metal has not deteriorated at the weld. In the twelve tests referred to, not one specimen broke through the welded portion.

◆

BLONDLOT'S N RAYS.

The steady stream of investigations arising out of M. Blondlot's discovery shows no sign of diminution. M. Lambert, in the *Comptes Rendus*, of Jan. 25th, describes some interesting experiments, showing that these rays are emitted from fibrine which is undergoing the process of digestion. He ascribes the effect to the strains to which the fibrine is subject during the process. M. C. Gutton, in the *Comptes Rendus*, for Feb. 1st, describes researches showing that a non-uniform magnetic field produces similar effects to those of N rays, both upon a luminescent screen, and in increasing the sensitiveness of the human eye.

The same issue contains two further interesting papers dealing with the phenomena of N rays. A. Charpentier finds that a strong source of N rays placed about 4 centimetres behind the top of the skull, and a little above it, not only increases the brightness and distinctness of faintly luminous

Dimensions.	Area.	Reduction of area at fracture.	Extension.		On Original Area.				Remarks.
			on 4 in.	on 2 in. at fracture.	Elastic Limit (Yield Point).		Maximum stress.		
					Pounds.	Tons.	Pounds.	Tons.	
	Square inches.	Per cent.	Per cent.	Per cent.	Per square in.		Per square in.		
Diam. in.									
0·249	0·0487	7·4	8·0		11491	5·13	20249	9·04	Broke outside datum points
0·248	0·0483	7·4	13·0		8803	3·93	22265	9·94	Ditto do.
0·254	0·0507	7·5	8·0		11043	4·93	19868	8·87	Ditto do.
0·252	0·0499	7·4	11·7		14358	6·41	16150	7·21	Ditto do.
0·252	0·0499	7·7	13·0		21996	9·82	21996	9·82	Ditto do.
0·250	0·0491	7·6	9·0		14134	6·31	19622	8·76	Ditto do.
0·250	0·0491	7·7	9·0		14134	6·31	14134	6·31	Ditto do.
0·254	0·0507	7·9	11·0		15030	6·71	24304	10·85	Ditto do.
0·251	0·0495	7·8	7·8		14940	6·67	20361	9·09	Ditto do.
0·253	0·0503	7·7	14·0		10236	4·57	19152	8·55	Ditto do.
0·250	0·0491	7·7	9·0		12320	5·50	20070	8·96	Ditto do.
0·247	0·0479	7·7	9·0		8422	3·76	18704	8·35	Ditto do.

objects, but, even in absolute darkness, gives rise to the sensation of a faintly luminous cloud, evidently due to excitement of the visual nerve centre. The effect is observed very distinctly when the rays are guided by a copper wire from a more distant source to the point indicated. When this plate is placed over the seventh cervical vertebra, it gives rise to an enlargement of the pupil of the eye. M. Charpentier points out that the increase of luminosity mentioned above is not due to this enlargement, as it remains the same when the objects are viewed through pin-holes. E. Meyer finds that the emission of N rays by plants is unaffected by light, being the same in darkness as in light. Seeds allowed to germinate in the dark emit the rays like those germinating in the ordinary manner, even if enclosed in a leaden box, which would prevent any possibility of the storage of N rays reaching the seeds from an external source. E. Bichat, in the *Comptes Rendus*, for Feb. 8th, gives a simple explanation of the guiding of N rays by means of a wire, showing that the transmission is due to successive reflection, in exactly the same manner that light may be guided through a curved glass tube. A glass rod may be used in place of a wire. A number of observations described by M. Charpentier, in the *Comptes Rendus*, of Feb. 15th, appear to be confirmatory of M. Bichat's explanation.

RECENT EXPERIMENTS WITH N RAYS.

LATELY M. Blondlot has brought in a new and trustworthy witness to his discoveries, *i.e.*, photography. N rays have no action on the photographic plate, but their presence can be revealed by an electric spark, the image of which on the negative appears darker and larger than when there are no rays. Fig. 1 is a horizontal section of the apparatus employed. AB is a negative, 13 cm. broad, E is the spark surrounded by a cardboard box, FGHI, open only on the side facing the plate and allowing the spark to act on one half OB of the plate only. CD is a lead screen coated with wet paper and forming part of the frame which contains the negative. A pencil of N rays falls on the screen CD, their path being indicated by the arrow NN. As is shown in the figure, the spark is then sheltered from the rays as long as it is acting on the half-plate OB.

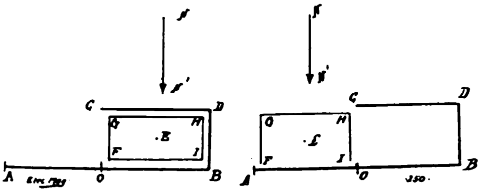


FIG. 1.

If now the frame containing the plate be moved in the direction OB, and for a distance equal to OB, then AO takes the place of OB and the spark acts on AO while it is receiving the N rays, as the screen CD is no longer interposed. Two images are thus obtained side by side, the exposure being five seconds in each case; to increase the effect the same double experiment is repeated several times on the same plate. By a judicious arrangement of guides and buffers, and by using a metronome to keep the same rythm in every movement, perfect regularity may be maintained while moving the plate backwards and forwards.

The spark produced by an induction coil occurs between two irridised spongy platinum points, very carefully made and polished, fixed to the two jaws of a pair of wooden pliers which tend to close by elasticity and are kept apart by a micrometric screw. A pane of frosted glass is interposed to dim and spread out the light proceeding from the spark, thus producing on the negative a large stain such as is shown in the figures. The difficult part of the experiment consists in regulating the spark, as this must be both regular and small to be sensitive to N rays. Blondlet made about forty such experiments, in which he employed in turn, as sources of N rays, a Nernst lamp, compressed wood, tempered steel, toughened glass, etc. Several eminent physicians were present during these experiments.

ELECTRO-PHYSICAL NOTES.

Passage of Cathode Rays through Metals.

IN a paper read before the German Physical Society, Berlin, Jan. 8th, Professor E. Warburg, propounded a theory for the passage of cathode rays through metals, in which the following points were emphasised.

(1) The power centres in aluminium traversed by cathode rays will act on the electrons with a force inversely proportional to the 1.45th power of distance.

(2) Each electron, in striking a power centrum in aluminium, will lose an amount of speed equal to an average of 4%.

(3) The mean free paths of electrons in aluminium are proportional to the 8.9th powers of the velocities, the mean free path for velocity corresponding to the discharge potential of 15,800 volts being 0.0018 m.m.

The author's theory, being based on hypothesis analogous to those made in the kinetic theory of gases is applicable also to the reflection of cathode rays.

Cooling of Bodies Heated and Electrified under the Influence of Radium.

IN the course of an experimental investigation of the influence of radium on the rate of cooling of a body placed in a gaseous medium, Mr. Georgiewsky in a paper recently read before the Russian Physico-Chemical Society, arrives at the following conclusions:

1. The rate of cooling of heated bodies in the various gases is not modified under the influence of radium.

2. The rate of cooling of non-electric heated bodies, placed n one of the gases examined (hydrogen, lighting gas, air and carbonic acid), on being exposed to the action of radium, is augmented when the heated bodies are electrified. The rate of cooling in this case, will augment not only under the simultaneous influence of the α, β and γ rays of radium, but also under the exclusive action of β and γ rays.

3. The increase in the rate of cooling of a heated body is greater as the body is negatively charged.

4. The relations existing between the increase in the thermic conductivity and the potential of a charged and heated body may be represented by means of curves analogous to those by which Mr. Townsend expresses the connection between a : p and x : p for the same gases.

Action of Radium on Vacuum Tubes.

VACUUM tubes are frequently used as detectors of electro-magnetic fields, the presence of which is indicated by the luminescence of the tube. As pointed out by D. M. Sokoltzow, in a recent paper before the Russian Physico-Chemical Society, the sensitiveness of a similar vacuum tube may be increased when luminescence is produced by potential difference. Ionisation of the gas in the tube will take place, attended by a discharge phenomenon, through the gas corresponding to the luminosity observed; the field thus acts as an ioniser. If the field intensity be insufficient to produce this ionisation, the action of another ioniser may be resorted to. The author accordingly used radium to increase the sensitiveness of the tube. The latter was placed in an electric field, too weak to make any luminosity possible; as soon, however, as radium rays were allowed to act on the tube, a luminosity was noted, increasing with the effectiveness of the radium.

Electric Waves in High Capacity and Self-Inductive Systems.

IN high capacity and self-inductive electric systems, any temporary or permanent distribution of potentials is shown, by L. Hermann in *Annalen der Physik*, to be propagated in the form of a damped wave along the system, a stationary distribution of potentials being eventually arrived at in the latter case. Similar devices proved to embody to a certain extent a model of a nerve fibre, showing the so called "electrotonus," as well as the wave-shaped propagation of a local electric modification as attendant, for instance, on the excitation, and a rate of propagation of a low order of magnetism. The fundamental experiment by which Helmholtz determined the rate of conduction of a nerve may be imitated by means of the system in question; Helmholtz excited a nerve connected to a muscle both at a point near the muscle and another distant point, recording graphically the reaction, which in the latter case would begin later than in the former.

The Chord Galvanometer.

IN a paper recently read before the Amsterdam Academy of Sciences, W. Einthoven describes a novel galvanometer formed of a silvered quartz thread stretched like a chord in an intense magnetic field. As soon as this thread is traversed by the current it undergoes a deviation perpendicular to the direction of the magnetic flux, this deviation being directly measured by means of a microscope provided with an eye piece micrometer. This instrument may under certain conditions serve to reveal currents smaller than 10^{12} amps. The tension of the chord may be regulated so that a current with a given intensity will just produce a deviation determined beforehand. The image of the middle of the chord, 660 times magnified, is projected on a slit, perpendicular to the image of the chord. In front of the slit, there is a cylindrical lens, the axis of which is parallel to the slit; whereas behind, a photographic plate is moved in the direction of the image of the chord. At the same time a system of co-ordinates is projected on the sensitive plate according to Garten's method, the horizontal lines being obtained by means of a millimetric glass scale placed immediately in front, so that the well defined shadows of the millimetric division are thrown on the latter, whereas the vertical lines are produced by the spokes of a uniformly rotating disc intercepting periodically the light falling on the slit. The diagram thus obtained shows the periodical deflection to be strictly proportional to the intensity of the current.

On a Novel Radiation Phenomenon.

MR. J. J. TAUDIN CHABOT some little time ago ascertained whether selenium in its conductive modification, being sensitive to light, gave rise to radio-active phenomena. To this effect, he used a selenium cell of Shelford Bidwell type, the effective mass of which was uniformly distributed on the surface of a platinum wire. After having been in the dark for many weeks, the platinum selenium surface was covered, at a red illumination, with a sheet of silver bromide jelly to which a sensibiliser absorbing the yellow and green rays was added, an aluminium strip, bent at right angles, being interposed. After the whole system had been kept in the dark for another 48 hours, the same experiment was repeated, using a fresh silver bromide jelly sheet, while a current of about 110 micro-amp. traversed the selenium. The following effects were observed on the developed jelly sheet: In the first case, some bright spots corresponding apparently to the outline of the aluminium angle were noted on a dark background, whereas, in the second case, a dark silhouette of the whole of the angle without any details resulted in a bright background, some brighter narrow transversal bands being visible at the same time. These bands were produced more efficiently in repeated expositions, thus allowing it to be ascertained that they are due either to the parallel platinum wires, or to the selenium interposed between each two of these, or finally, *to the points of contact* between the platinum and selenium, where the Peltier effect must give rise to an evolution of heat either positive or negative, on the passage of the current.

The Richard Cinemometer.

ON May 16th, 1901, the Société des Electriciens inaugurated a competition for the best design of an apparatus to measure accurately the angular velocity of a machine turning at about 125 revolutions per minute, during the 250th part of a revolution, this mean speed being that of the alternators at the Moulineaux power house. M. Richard has constructed an apparatus which is believed to fulfil the requirements of the society. He employs an isochronous and easily adjustable regulator whose speed could be compared to a kinematic mechanism, revolving at the same rate as the crankpin or rotating organ of the machine under experiment. This comparison can be made with a high degree of accuracy, as what is measured is not the absolute speed of the machine but its relative velocity with regard to the uniformly rotating body. An index, moving over a dial divided into 250 parts, shows the differences of velocity. In the apparatus two friction plates revolve uniformly by clockwork. A friction roller, whose position relative to the axis of the discs can be adjusted by a milled nut, imparts its motion to one of the wheels of a differential train, the other wheel being driven by the shaft under experiment. By suitable adjustment the first wheel can be given the same velocity as the second, the velocity being read in revolutions and fractions of revolutions per second, being marked by the index on a graduated scale. Uniform rotation maintains the system in equilibrium, but any variation in the velocity is recorded in degrees by a style moving vertically over a chart on a revolving drum. A heavy fly-wheel was used in adjusting and standardizing the apparatus.

Influence of the Medium on the Induction of Currents.

Mr. B. Weinberg, in a paper recently read before the Russian Phys. Chem. Society, emphasises the variation in the magnetic force and the magnetic induction (termed "magnetic polarisation" by Hertz), produced by a change in the infinite medium surrounding a system of magnets and conductors.

As the case of an infinite medium is unrealisable, the author next considers the form of such a surface that the variations in the magnetic force and polarisation are the same as for an infinite medium. As the direction of these vectors is invariable in the latter case, it is shown that the surface of the medium should coincide with lines of force and with equi-potential surfaces. On this account the variations undergone by the magnetic force and polarisation in the field of the magnets and in the field of the current are further investigated in the case of the surface of the medium coinciding with lines of force or with equi-potential surfaces.

All the theoretic conclusions relative to the magnetic polarisation have been qualitatively confirmed under variable conditions by numerous experiments on induction currents in conductors surrounded alternatively by air and iron filings.

The conclusions arrived at in the first part of this paper are applied to a study of a possible variability of the co-efficient l in Laplace's formula

$$df=\frac{l\ \text{imds.sm (ds.r)}}{r2}$$

in different media. Comparisons of the currents induced by a magnet in coils surrounded by air, water, vaseline oil, and solutions of H_2SO_4, and Mn_2Cl_6 (as made by a differential method) show this co-efficient to be most likely invariable within 1 : 100,000 and certainly 1 : 30,000 of its value.

On the Heat given off from Radium.

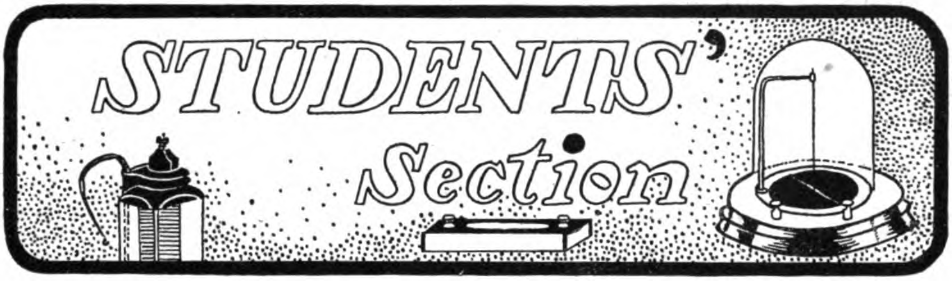
Prof. P. Curie and A. Laborde some time ago observed that radium chloride would continually emit amounts of heat as high as about 100 grm. calories per second and per grm. of pure radium. In a note recently read before the Berlin Academy of Sciences, Professors C. Runge and J. Precht tried to ascertain whether the kinetic energy of the electrically charged particles projected from the radium salts is a quantity of the same order of magnitude. The authors repeated the experiment of the two French experimenters, comparing the amount of heat given off by the radium salt with the heat given off from a small platinum spiral traversed by an electric current. Having enclosed the sources of heat in a lead capsule, the walls of which were about 3 mm. in thickness, they once more compared the amounts of heat. The results thus obtained confirm the experiment of Curie and Laborde, showing that the kinetic energy of the particles positively and negatively charged and projected from the radium, as far as they are stopped by the lead walls, is only a small fraction of the total heat evolved by the radium. On account of the noticeable absorption which all the effects of radium will undergo under the action of the lead layers, it is safe to state that by far the greater part of the particles projected were arrested by the lead capsule. To show how it is possible that a substance may give off continually high amounts of energy, the author draws attention to the laws of electrolysis, whence may be inferred the magnitude of the forces of attraction and repulsion between the electrically charged atoms and electrons.

Theory of Radio-Active Phenomena.

The theory propounded by R. Schenck in a paper recently read before the Prussian Academy of Sciences, meeting of January 7th, 1904, is based on the hypothesis that electrons, in connection with chemical equilibrium phenomena, and more particularly in the equilibrium between oxygen and ozone, are controlled by the law of mass effects (law of Guldberg and Waage). In a previous paper the author had pointed out that ozone behaves like a radio-active body, and that on being dissociated, *i.e.*, converted into oxygen, will become a conductor of electricity, giving off gaseous ions: on the other hand its formation takes place in conjunction with certain electric phenomena whenever gaseous ions are present. This is a reversible process, and if gaseous ions be considered as material particles, ozone may be said to be formed from oxygen and gaseous ions, that is, a *chemical compound* of electrons and oxygen, or else an *electronide* of oxygen, both electrons and atomical ions being controlled by the mass law in the same way as electrolytic ions and electrical neutral molecules. As the equilibrium constant of this reaction will decrease for increasing temperatures, the constancy of ozone must augment in proportion; the concentration of the gaseous ions given off from ozone will also be smaller than with low temperatures.

The author allows for the well-known fact that strongly active radium compounds will give off a small amount of ozone, by the ionisation of air due to the gaseous ions given off from radium, in virtue of which ozone is produced from the surrounding oxygen. The hypothesis is suggested that radium and analogous substances are also *electronides*. It is thought probable that radio-active substances were produced by volcanic phenomena attended by violent evolutions of electricity. As in many slow reactions, such as the oxidation of organic substances, giving rise to the formation of ozone, the presence of gaseous ions has lately been ascertained, it is probable that many, if not all, chemical reactions are attended by the presence of such gaseous ions in variable quantities.

A Central Station Engineer says of "The Electrical Magazine": "I am sure it fills a long felt want, and I cannot praise too highly your reference section. You aim at saving the time of busy men, and as time is money, your magazine will prove a profitable investment to thousands."



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of *The Electrical Magazine* feels that something more is wanted, and the Associate Editors, will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

* * *

Montefiore Technical Institute.

By ENRICO BIGNAMI.

THE Montefiore Technical Institute at Liège is now in the twentieth year of its foundation, and a few details of an establishment which, in some respects, claims to be the first of its kind in Europe, can hardly fail to be of interest to our student readers.

The Institute has been attended by 1760 pupils to date, from nearly all parts of the world, including English, Canadians, Americans, Turks, Japanese. It may, therefore, be considered as one of the most cosmopolitan establishments in existence.

Two classes, or divisions, of students are received, desirous of qualifying for the diploma granted by the Institute of Electrical Engineers:

1. Engineers and Army officers, who can qualify for the diploma in devoting one year to the study of electro-technics at the Institute. These students form the Engineers' section.

2. Youths possessing a general knowledge of mathematical and physical science, and who qualify themselves for examination for the diploma by a course of two years at the Institute. Students of this category form the division of student-electricians.

From time to time the Institute has required to be enlarged, in consequence of the constantly increasing number of students. The extensions have been carried out at the cost of M. Montefiore, from whom the Institute has derived its name, he being the founder of the establishment.

The original building, horse-shoe of form, comprises, on the ground floor, workshops and laboratories. On the first floor are situated elementary measurement and research rooms. On the second, advanced measurement, drawing and clerical offices. In the workshops there is comprised a complete installation of wood-working machinery, lathes, milling, boring and planing machines—in all, a complete engineering equipment—the whole driven by electro-motors. The electrical laboratory contains some thirty machines, dynamos continuous and alternating current, with a number of transformers, one of which can be worked to a pressure of 100,000 volts. Every variety of electrical measurement can be demonstrated in this department.

The basement is occupied by a battery of accumulators, with a capacity of 1,000 ampère-hours. There are also an electric furnace and stove rooms. In order to accustom the students to the practical, everyday working of an electrical installation, the plant for lighting the premises has been installed in a separate building, together with that for charging the accumulators and supplying energy to the motors.

The boiler house contains two steam boilers with a heating surface of 80 square metres, which supply a steam engine and serve to heat the building. The power-house is equipped with a continuous current dynamo set of 20 h.p., and another of 30 h.p. which give continuous or multiphase current; a motor generator is also installed, which is supplied from the town's electric mains. There are five main switchboards controlling the various departments, with each connection denoted on a marble slab. A Swiss commutator controls the different circuits—light and power, experimental circuit, workshops and laboratories, as well as a special circuit for electro-chemical experiments.

A special building, carefully protected from the effects of vibration, is devoted to research work of great precision and for calibration.

The new buildings constructed by M. Montefiore include a lecture theatre, accommodating an audience of 300 students, a reception hall, and a museum. Besides these, the founder of the institute has had the care to provide a club for the association of the old students, and which can be shared by actual pupils during their course of study. The club contains rooms for social purposes; for study and conference, and also a well-equipped library. The pupil is at liberty to spend the whole of his time at the club, beyond the hours actually required at the institute.

The special instruction given at the institute consists of practical courses in the following subjects :—

(1) A course in theoretical electricity and magnetism.

(2) A course in electrical measurements.

(3) A course in electro-technics, divided in three parts : (*a*) The study of electrical generators, motors, and transformers. (*b*) The application of electrical energy to lighting, electrical transmission, electric traction, and electro-metallurgy. (*c*) Telegraphs and telephones.

(4) A general course of practical exercises through workshops, laboratories and demonstrative work.

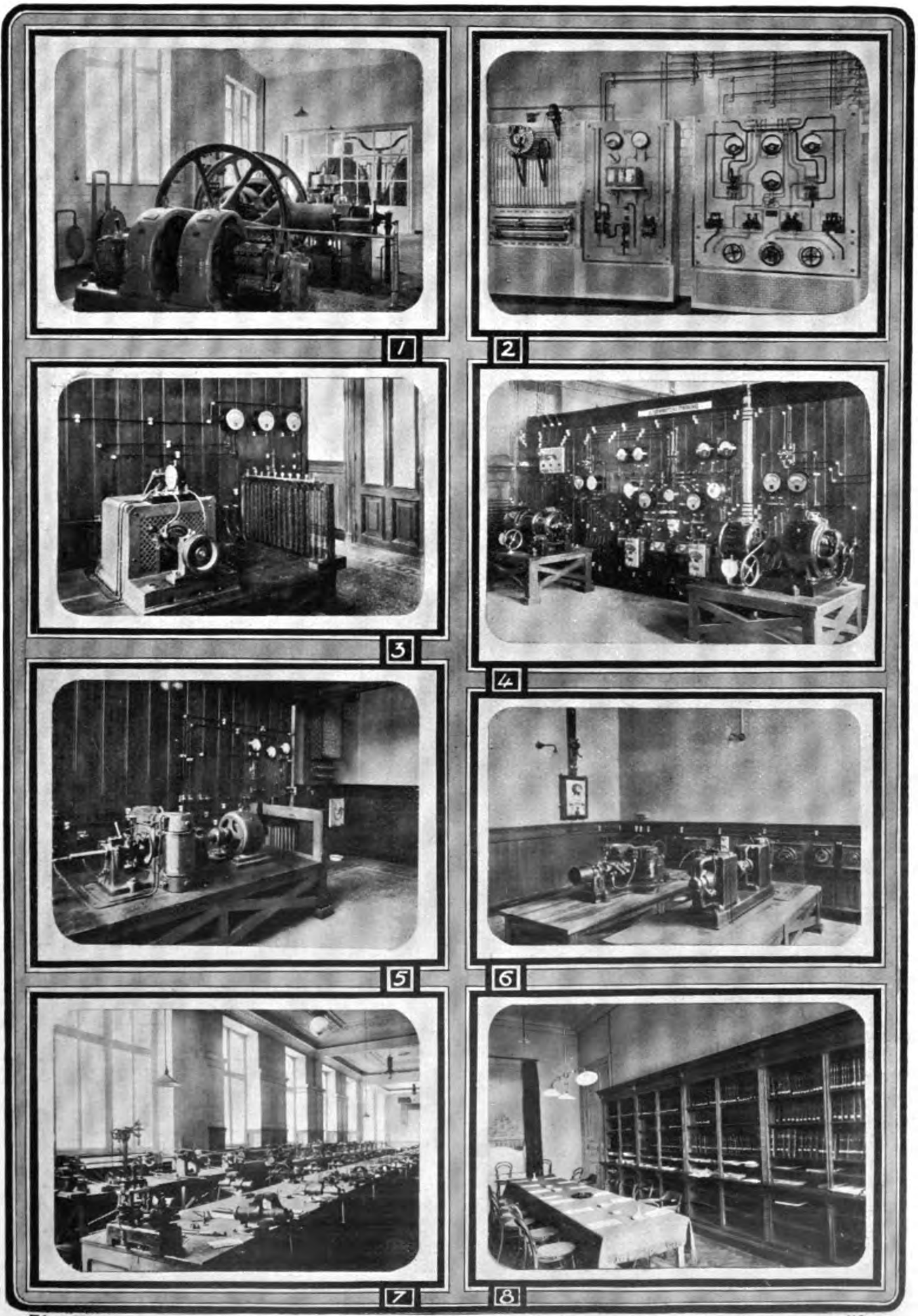
It may be said the great development attained in these exercises is a characteristic feature of the Liège Institute. The students commence by workshop practice, which familiarises them with the constructional details of the working of the apparatus they are required to handle, and gives them the necessary knowledge to permit them to carry out electrical manipulations successfully.

The students then are engaged in laboratory practice in the application of elementary measurement methods by resistances; in E. M. F's. and other details. They are required to set up circuits and to themselves instal all the measurement apparatus necessary for trials, for it is recognised that the installation of instruments is one of the chief difficulties which confronts the student at the outset of his experience. Particular attention is devoted to the discussion of results. Initiated by this preparation as to the precautions which must be taken in the manipulation of measurement instruments, the pupils can approach the practical study of electrical generators, motors, transformers, lamps, etc.

In connection with the laboratory work, the students are applied

Montefiore Institute. The Main Staircase.

M. Montefiore.



Elec: Mag: 119

1. *Power Plant.* 2. *Power Switch Board.* 3. *D.C. Motor Test.* 4. *Asynchronous Motor Test*
5. *D.C. Dynamo Test.* 6. *Motor Generators.* 7. *Corner of Workshop.* 8. *Library.*

MONTEFIORE INSTITUTE.

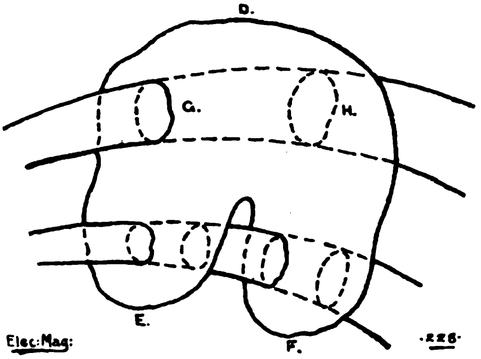


FIG. 2.

current into it—must equal the total number of tubes leaving the surface—*i.e.*, withdrawing current from it; so that the algebraical sum of all the currents traversing the closed surface is zero. For if each tube is endless, it is clear that if it anywhere enters the closed surface, as at G, it must at some other place, such as H, emerge from it; for each entrance there must be an emergence. The same tube may, of course, as shown in the lower part of Fig. 2, enter and leave the surface several times before finally emerging from it.

These effects may be simply and accurately described by saying that the flow of an electric current is a *circuital* phenomenon (or one taking place along *closed* or *endless* loops or *circuits*). It used to be described by saying that the flow of an electric current is analogous to that of an incompressible liquid, or that "electricity behaves like an incompressible liquid"; for if we consider a vessel containing an incompressible liquid in motion, and if we draw a closed surface in the mass of liquid, then it is clear that on account of the assumed incompressibility, the rate at which the liquid is entering the closed surface at any instant must equal that at which it is leaving it.

Although the circuital principle as applied to electric currents was recognised at a very early date in its application to continuous conducting circuits, its applicability was denied in considering cases where the conductor along which the flow of current was taking place terminated, as, *e.g.*, in the case of an insulated conductor which was given a charge by connecting it to one terminal of a battery. It was formerly supposed that on establishing connection with the positive terminal of the battery, a rush of current took place into the conductor, but that on reaching the surface of the conductor the current was suddenly arrested, the tubes of flow *terminating* at its surface. It was at that time usual to speak of *open currents*, and the existence of such currents was considered possible. According to this older view, when a short, straight wire is placed with its length perpendicular to a magnetic field, and is then set in motion across the field, there is, so long as acceleration is taking place, a current in the wire, the current starting from one end, flowing along the wire, and terminating at the other end; the wire was regarded as filled with tubes of flow which had a *beginning* and an *end* at the extremities of the wire; the principle of circuitation being considered inapplicable in this case. ***It was one of Maxwell's most important contributions to electromagnetic theory, that he denied the existence of so-called "open currents," and extended the principle of circuitation to every possible case.***

ALFRED HAY, D.SC.

[*Prof. Hay will continue with this subject in an article next month*].

◆

PROBLEMS IN DYNAMO DESIGN.—I.

THE determination of the winding of the field magnet coils of a dynamo is an important problem which may be solved in different ways according to the conditions given. If the voltage E_m, at the terminals of the field windings, the excitation in ampere-turns and the mean length of the field magnet winding be given, as in the following example, the solution is simple.

Problem. The field magnet coil of a dynamo requires an excitation of 4,000 ampere-turns to produce the necessary flux. The internal diameter of the coil is 12 inches, and the external diameter is 15 inches. What size of copper wire must be used if the terminal PD is 100 volts, and what is the resistance of the coil? The length of the coil is eight inches.

Solution. Let S = total number of turns forming the coil.
l_m = the mean length of a turn.
r = the resistance of the mean turn.
C = the current.
E_m = the terminal PD.
then Sr = total resistance of the coil.

$$\text{and} \quad C = \frac{E_m}{Sr}$$

$$\therefore \text{ excitation } CS = \frac{E_m}{Sr} \times S = \frac{E_m}{r}$$

$$\text{but } r = \frac{\sigma \times l_m}{\text{area}}$$

therefore, employing the mil-foot units, σ, the resistance of one mil-foot of copper at 60°C, is approximately 12 ohms, and if l_m be given in feet and the area A be given in circular mils, $A = d^2$ circular mils, where d is the diameter of the wire in mils ($\frac{1}{1000}$th of an inch). *Note*, the area of any circular wire in circular mils is found by simply squaring the diameter in mils.

$$\therefore r = \frac{12 l_m}{d^2}$$

Substituting this value in the equation $CS = \frac{E_m}{r}$ we have

$$CS = \frac{E_m}{\frac{12 l_m}{d^2}}$$

$$\text{and } d = \sqrt{\frac{12\, CS\, l_m}{E_m}} \text{ mils}$$

When the core of the field magnets is circular, and D and D_1 are the internal and external diameters in inches of the field magnet coils, then, obviously,

$$l_m = \frac{(D + D_1)}{2} \times \frac{\pi}{12} \text{ feet}$$

and the fundamental equation becomes

$$d \text{ (mils)} = \sqrt{\frac{12\,CS\,\dfrac{(D+D_1)}{2}\,\dfrac{\pi}{12}}{E_m}}$$

$$= \sqrt{\frac{1{\cdot}57\,CS\,(D+D_1)}{E_m}}$$

By inserting the given values we get

$$d = \sqrt{\frac{12 \times 4000 \times \dfrac{(12+15)}{2 \times 12}\,\pi}{100}} \text{ mils}$$

since $\frac{12+15}{2}$ = mean diameter in inches

and $\frac{(12+15)}{2 \times 12}\pi$ = mean length of a turn in feet.

$$\therefore d = \sqrt{20 \times 27\pi} \quad \text{mils}$$

$$= 41{\cdot}18 \text{ mils} = 0{\cdot}04118 \text{ inch.}$$

To determine the total resistance of the winding it is necessary to find S the total number of turns :—if we assume that the insulation of the wire increases the diameter to 0·054, *i.e.*, adds 13 mils to the diameter, then

$$S = \frac{\text{length}}{d} \times \frac{\text{depth}}{d} = \frac{8}{0{\cdot}054} \times \frac{1{\cdot}5}{0{\cdot}054}$$

$$= \frac{12}{0{\cdot}002916} = 4{,}100 \text{ turns (say)}$$

$$\text{and } C = \frac{4000}{4100} = 0{\cdot}9756 \text{ ampere}$$

$$\therefore Sr = \frac{E_m}{C} = \frac{100}{0{\cdot}9756}$$

$$= 102{\cdot}5 \text{ ohms}$$

Problem in Alternating Current Working.—I. If the self-induction of a circuit be 0·1 henry and its resistance 10 ohms, at what frequency will an increase of 1 per cent. on the self-induction be more important than a diminution of 50 per cent. in the resistance? *(City and Guilds Examination in Electric Lighting and Power Transmission, Ordinary Grade, 1900).*

Solution. The impedance of an inductive circuit is $J = \sqrt{R^2 + p^2L^2}$

Where R = resistance, pL = reactance, and

$$p = 2\pi \sim$$

It will probably simplify the solution of this problem if we first determine the frequency—$\sim$—at which the change in the self-induction is just balanced by the change in the resistance, for then a greater frequency will be the one required. On the above supposition

$$\sqrt{10^2 + (2\pi \sim \times 0{\cdot}1)^2} = \sqrt{5^2 + (2\pi \sim \times \frac{101}{100} \times 0{\cdot}1)^2}$$

$$\text{and } 100 + \frac{4\pi^2 \sim^2}{100} = 25 + \frac{4\pi^2 \sim^2 \times 1{\cdot}0201}{100}$$

$$\therefore \frac{4\pi^2 \sim^2}{100}(1{\cdot}0201 - 1) = 100 - 25 = 75$$

$$\text{and } \sim^2 = \frac{7500}{{\cdot}0201 \times 4 \times (3.1416)^2}$$

$$\therefore \sim = 97{\cdot}2$$

Therefore, at a frequency greater than 97·2 the impedance is increased by increasing the self-induction of the circuit by 1% although the resistance of the circuit is reduced to one-half. Thus, at a frequency of 100 periods per second the impedance is 63·64 ohms if no change be made, and is 63·68 ohms if the change be made.

ELLIS CRAPPER, M.I.E.E.

◆

What is Electricity?

IN a recent issue of the ***Western Electrician***, Mr. A. A. Skeels, writing upon this subject, states that just as it is difficult to explain the ordinary phenomena of sound without knowing the existence of air, so to understand the nature of electricity and to explain electrical phenomena we must grasp the idea of the existence of that substance, which in degree of subtility lies between ordinary gases and the ether, and which is the medium for the transference of that energy we call electricity.

In referring to the structure of matter the author states that the atom is a group of smaller parts which he names sub-atoms, the sub-atom is a group of still smaller parts named sub-subatoms, the sub-subatom is a group of still more minute parts, and soon down to an ultimate atom, which can be divided no further. Ordinary gases, liquids, and solids are made up of groups as previously mentioned, and we thus have sub-subgases, sub-subliquids, etc., and so on; and electrical and magnetic phenomena and radiant energy give evidence of the existence of a sub-subgas which is identical with what is known as the ether. Under ordinary conditions all molecules, atoms, sub-atoms, sub-subatoms, etc., are in motion; that is, possess kinetic energy and also all have energy of position or potential energy. In the processes of nature there is a continual transformation of potential energy to kinetic and kinetic to potential. Phenomena show that the sub-subgas (ether) is, as far as observation goes, everywhere present, but the sub-gas is not so plentiful, and exists only as an atmosphere around molecules and atoms.

A Difference.

THE difference between electrical theory and practice was pointedly remarked upon by P. M. Lincoln before the Canadian Electrical Association. The fresh college graduate, if questioned upon the amount of distance to be allowed between conductors and the high-tension transmission line, will put forward premises involving the jumping distance of the voltage to be used, the length of span, the sag, and perhaps a liberal factor of safety. Experience, however, will show that these are wrong, and that the equation to determine the spacing of high-tensioned wires depends very little on the voltages to be carried, and almost entirely on such things as the average length and ohmic resistance of cats, the spread of wings of owls, cranes and eagles, and the average length of scrap baling wire, together with the strength of the average small boy's throwing arm.

We are prepared to supply "The Electrical Magazine" on special terms to students, and invite enquiries from the heads of Technical Institutions, students, lecturers, regarding the same. The journal contains so much of value to students that a copy should be in the library of every electrical training college.

FROM PROFESSOR to Student.

Under this heading we shall deal with the queries of Students on matters directly relating to the science and application of electricity. Letters addressed to "The Associate Editor, Students' Section," should be received before the 1st of the month, if replies are needed in the next issue. A number of replies are unavoidably held over till next month.

I AM a poor boy who has won scholarships enabling me to attend a Grammar School for the last six years. I am also holding scholarships to the value of £90 per annum for three years from October next, with which I wish to train as an electrical engineer. I should esteem it a favour if you would advise me as to which is the best College or Institute for me to attend in London.

The most advanced technical instruction for an electrical engineer is to be obtained at the Central Technical College, Exhibition Road, S.W.; and if the writer of the above enquiry is sufficiently far advanced to pass the entrance examination (somewhat stiff), we should recommend him to become a student at this College. Failing this, he might try the Finsbury Technical College, Leonard Street, Finsbury, E.C.; or The Electrical Standardizing, Testing and Training Institution, Faraday House, 8 and 10 Charing Cross Road, W.C.; or University College, Gower Street. There are, in addition to the above, a very large number of Polytechnics and Institutes in various parts of London, and in most of these there are provided complete day courses of study in various branches of Engineering. We should advise our correspondent to obtain prospectuses of the Institutions mentioned, giving particulars of fees, entrance scholarships, etc., and to decide for himself on the basis of this information, as to which college is likely to afford him most chances of success. We need hardly add that there is no such thing as *the* best college for anybody and everybody—so much depends on the particular circumstances of each case.

WHAT are the distinctive functions of the various small machines generally found in central stations? I refer more particularly to boosters, balancers, motor generators, and rotary converters. If it is not too much to ask, I should be glad to know the exact purpose of each of these, and also the chief constructional differences that exist between them; also which of the above are applied to continuous and which to alternating currents—if not applicable to both.

The term *booster* is generally applied to an auxiliary continuous-current generator connected in series with the main generator or generators, to produce an increase of voltage. For various reasons, it is convenient to run the main generators at an approximately constant voltage, and to provide any extra large increase of voltage which may be required by means of a booster. The design of a continuous-current generator whose voltage is required to vary within wide limits, and run sparklessly at all voltages, presents considerable difficulties; and such a generator will necessarily be heavier and more expensive than one required to operate at the lower limit of voltage only. The most important use of a *booster* is for charging the batteries of secondary cells to be found in almost every continuous-current station. The p.d. of a secondary cell towards the end of its discharge drops to 1·8 volts; this will accordingly represent the voltage contributed by each cell when supplying current to the network. During *charge*, however, the terminal p.d. of each cell may rise to as high a value as 2·6 volts. Now it is frequently convenient to utilise part of the current from the main generators for supplying the network, and the remainder for charging the cells. It is the additional voltage required for charging the cells that is provided by the booster. Boosters may, however, be also applied to other purposes, as, *e.g.*, to compensate for the drop along an exceptionally long feeder, or to prevent too large a p.d. between any two points of an electric tramway track (the booster being in this case introduced into the circuit of the return feeder).

A *balancing set* is used with a three-wire continuous-current system of distribution, and is intended to maintain equality of the p.d.s between the neutral wire and each of the outers. It consists of two shunt-wound machines whose armatures are mechanically coupled, and are connected in series across the mains, each armature developing an e.m.f. corresponding roughly to half the voltage across the outer conductors. When balance is disturbed, one of the machines begins automatically (by reason of the shafts being mechanically coupled) to act as a generator, the other as a motor, and this prevents a rise of voltage on the lightly-loaded side, and a drop on the heavily-loaded side of the three-wire system—an effect which would otherwise take place. Not unfrequently, the two balancers and two boosters (one for each side of the three-wire network) are all placed in line with each other and are mechanically coupled, forming a combined *balancing and boosting set*.

A *motor generator* is, as the name indicates, a combination of motor and generator, the two machines being quite distinct and mechanically coupled. A motor-generator may consist either of two continuous-current machines, or of a combination of a continuous-current machine with an alternating-current one (either of which may act as a generator or motor). The object of a motor-generator is to produce either a transformation of voltage (both machines continuous-current) or a transformation from continuous to alternating current, or *vice versa*.

A *rotary converter* is a single machine which combines the functions of generator and motor. Its armature is provided with the ordinary continuous-current winding, but has, in addition to the commutator (representing the continuous current side), a set of slip-rings (representing the alternating-current side). The object of a rotary converter is the transformation of (generally three-phase) alternating into continuous current. The same end may be attained by the use of a motor-generator; but the rotary converter has the advantages of cheapness and higher efficiency; its main disadvantage being the difficulty of regulating the voltage.

MANUFACTURERS' Section

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be *original* and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

The Engineering Standards Committee.

By W. NOBLE TWELVETREES,
A.M.I.E.E., M.I.Mech.E.

THE influence of electrical engineering has extended so widely that in the present day almost every department of industry is affected thereby. Consequently, while the deliberations of the electrical section may appeal more particularly to our readers, the entire work of the Engineering Standards Committee is necessarily of much interest. The operations of the Committee were first commenced in April, 1901. Work of the kind undertaken must inevitably be laborious and protracted, and although comparatively few reports have actually been completed up to the present date, a large amount of information and material has been brought together, and numerous specifications and findings are nearing completion. The first report published was that on "Standard Rolled Sections" for structural work, drawn up by the Committees on "Sections used in Ship-building," on "Bridges and Building Construction," and on "Railway Rolling-Stock Underframes." We are pleased to announce that the sections so standardised have been adopted by the great Government Departments, and are gradually finding their way into general use. A standard specification for "Steel Used in Ships," prepared by the Committee dealing with that department of work, has been formulated, and at the present time is under further consideration by the Committees on Bridges and Underframes. A valuable report has also been made by Professor Unwin on the work carried out by him for the Committee dealing with material used in the construction of ships. The Locomotive Committee has completed a report on standard types of locomotives for Indian railways, and this report is now under the consideration of the Secretary of State for India. Some valuable information may be anticipated in the report of the sub-committee on "Copper and its Alloys," about to be published. The sub-committee on Railway Rails has made good progress with two series of standards. The sections proposed and the accompanying specifications have already been circulated among the chief railway companies and engineers of this country, and it is hoped that the complete report will be published at no very distant date. As our readers are aware, the sub-committee on Tramway Rails has already issued its report, and published a series of standard sections accompanied with a specification.

The Electrical Committee is dealing with a very large and important section of the work undertaken by the Engineering Standards Committee, and consists of the Electrical Plant Committee, under the presidency of Sir William Preece, and sub-committees on "Generators and Motors," "Transformers," "Physical Standards," "Nomenclature," "Telegraphs and Telephones," "Cables," an

"Electric Tramways." In addition to these, three other sub-committees, to deal with various electrical matters, are in course of formation. Considerable activity is being displayed by all these sub-committees, and some time will necessarily elapse before definite results can be made available.

It should be mentioned that in addition to the contributions made by the leading engineering institutions, railway companies and engineering firms, the Committee has received substantial support from His Majesty's Government. The grant for the current year, however, has been made dependent upon the amount subscribed by the various industries interested, and it is therefore very desirable that this condition should be widely known throughout the country. Our readers are probably as much interested as any class of the community in the important labours of the Engineering Standards Committee, and we hope that they will show their practical appreciation in such a manner that the work may not be curtailed for want of financial support.

* * *

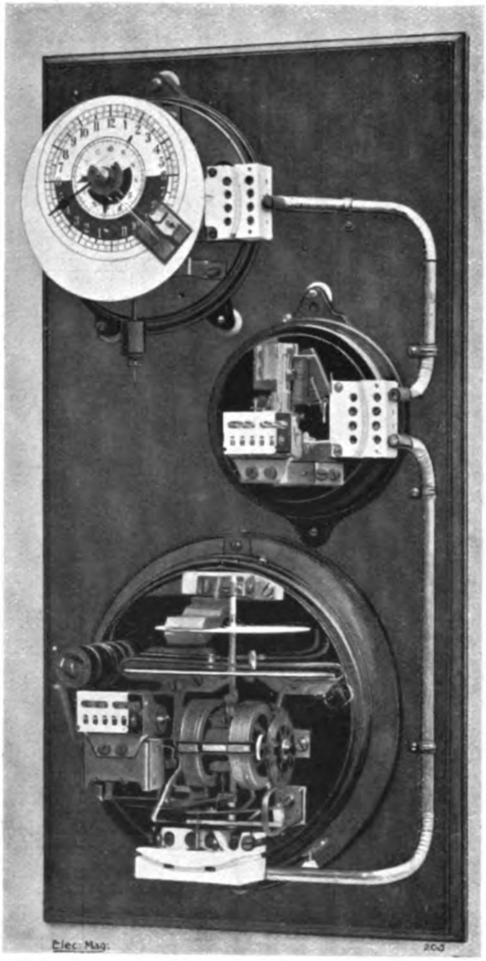
THE DOUBLE TARIFF METERS SYSTEM.

The primary object of the Double Tariff System is to encourage the use of electricity for other than purely lighting work, and, by creating a steady demand for current during the day time, to improve the economic conditions of central station generating plant. The adoption of the Double Tariff Meter System makes it practicable to supply current at high prices during the peak period, and low prices outside the peak period. An arrangement for automatically recording the energy consumption on separate dials for different periods of the day has long been desired by central station managers, and this has been practically realised in the apparatus introduced by The Electrical Company, of London.

In the E.C. Double Tariff System the apparatus employed consists essentially of an ordinary E.C. standard watt-hour meter registering the total consumption in kilowatt hours (B.O.T. units), and a tariff meter, also registering direct in kilowatt hours, electrically driven by the main meter at certain periods of the day, as determined by a contact clock, or "contactor," the latter being wound and re-set at monthly intervals. In making out the consumer's bill by the aid of such apparatus, two methods are possible, as will be seen from the following consideration :—

As the standard meter indicates the total consumption, and the tariff meter the consumption during any selected period, it is evident that, to obtain the individual quantities, the tariff meter reading must be subtracted from the total reading. Therefore, by causing the tariff meter to read the low priced units, it is possible to give the consumer a direct rebate on all the units registered on the tariff meter.

For example, let us assume the total consumption to be 1,000 units, of which total 200 are low priced units, the prices being, say, 6d. and 2d. respectively. Then the difference in the two prices is the amount of rebate per unit due to the consumer when using the energy on the lower rate.



Tariff Meter on Board.

The bill can then be made out as follows :—

	£	s.	d.
To 1,000 units @ 6d.	25	0	0
By 200 units @ 4d.	3	6	8
Net amount due	£21	13	4

The same result can, of course, be obtained by making the bill out in the following manner :—

Standard Meter Reading	1,000 units
Tariff Reading	200 ,,
Difference	800 ,,

	£	s.	d.
To 800 units @ 6d.	20	0	0
To 200 units @ 2d.	1	13	4
Amount due	£21	13	4

The latter method, however, involves calculations, which experience teaches are better avoided whenever possible in connection with consumers' bills. Bearing in mind the large number of meters which are already in use, it is

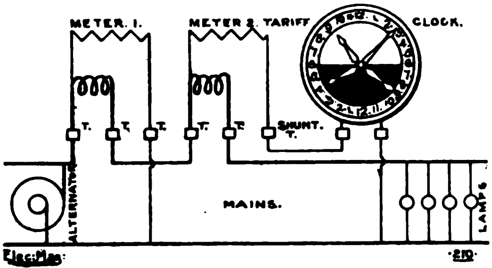


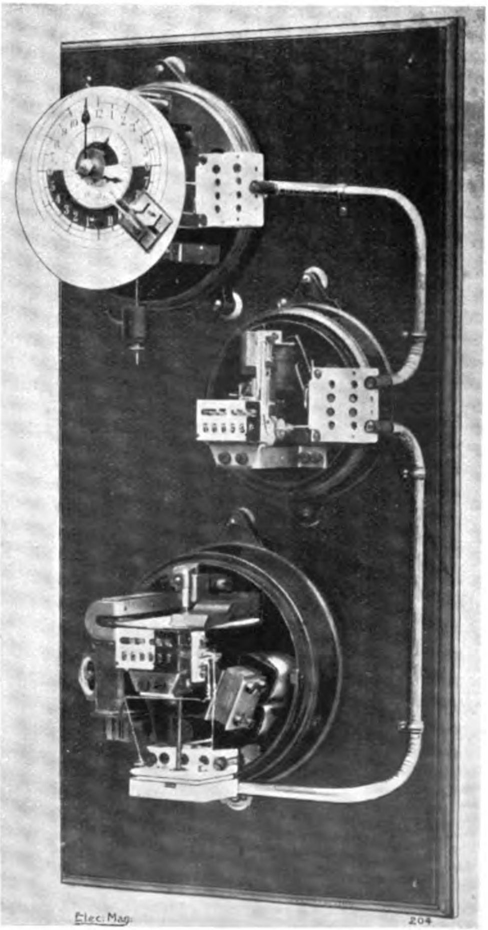
Diagram of Connections.

satisfactory to note that the E.C. "Contactor" has been so designed that by slight modification it can be used in conjunction with watt-hour meters of any make. The adoption of the system does not involve the supply of fresh meters; a point of much importance to those considering the application of the system.

As the apparatus has been placed on the market at a price which is by no means excessive, facilities are now available for developing the wide field which exists for the use of electrical energy in everyday life. With the exception of the very few places where coal is excessively dear, electrical energy can now be generated, distributed, and sold to the consumer for at least 10 hours out of every day at prices varying from 1d. to 4d. per unit, and 2d. per unit may safely be taken as the average price. With the general adoption and careful fostering of the tariff system, a great development beneficial alike to the electrical manufacturing industry and the public should result, as small manufacturers and those engaged in various industries would undoubtedly find electrical driving to be the cheapest and best in every way.

The E.C. Tariff Clock, or "Contactor," consists of a well-made clock of the pendulum type, which requires winding only once in 45 days. On the hour arbor is mounted a pair of cams controlling the contact springs, which ride upon the cams. The front of the clock is divided into day and night portions, coloured white and black respectively, covering the 24 hours, and a smaller dial is provided for setting the cams, to which are attached red and green hands. The method of setting is very similar to an ordinary alarm clock, the red hand being set to the "coming on" time, and the green hand to the "going off" time. All the electrical contacts are on the face of the clock, and clearly visible through the glass front, no contacts being hidden away. This is a good feature, inasmuch as inspection is made very easy. The case covering the clockwork is sealed to exclude dust, damp, and insects. For winding and setting purposes two metal-screwed openings are let into the glass front of the clock. These openings are closed by metal plugs, which are sealed in the usual manner with a cord and seal. A similar method, employed upon a larger scale for affording means of access to the pendulum bob and its locking screw for use during transit, can be also utilised for indicating whether the clock is screwed up plumb. It may perhaps be thought that the usefulness of the apparatus would be considerably increased if electrical winding for the clock had been adopted in place of monthly hand winding. There would, of course, be no great difficulty in doing this, although it would increase the first cost of the apparatus. The real difficulty is to make a clock that will keep good time over long periods, as a very small loss or gain per day will amount to a considerable percentage in the course of a month. This fact has been borne in mind in the design, and partly for this reason and partly on account of keeping the cost as low as possible, the mechanical hand-wind was decided upon. This naturally means an inspection every month or six weeks, but as the tariff times have to be set periodically, the hand-winding should occasion no inconvenience. Special attention has been paid to the design of the contact springs, which have proved to be most reliable and effective in actual practice for periods extending over 18 months of continuous work.

The Tariff Meter consists essentially of the E.C. Standard Counting Gear, driven by a simple electro-magnetic device, electrically connected to the main meter. When the circuit of the tariff meter is closed by the contact clock, the revolutions of the main meter are electrically communicated to the tariff meter counter by means of



Tariff Meter on Board.

a simple contact attachment, so that when the tariff meter is in circuit, its counter synchronises exactly with the main meter counter.

The Standard Meter is an ordinary standard watt-hour electricity meter of either direct or alternating current type, with the simple addition of the attachment already mentioned. This device can be fitted to any make of watt-hour meter on the market, either of the clockwork or motor type, as the device is mechanically actuated from the counting gear of the meter to which it is applied. Thus meters which have already been bought can be utilised if necessary, and the advantages of the Double Tariff Meter System can be secured without involving the purchase of new meters of the E.C. type. Objection is often made to apparatus of the kind here described, on account of its inherent delicacy and complication, but to obtain certain desirable results such features cannot always be avoided. After all, the satisfactory working of any complicated piece of mechanism depends upon the perfection of its individual parts, and upon the care with which these parts are protected when under working conditions. At the works of the Electrical Company special machinery has been laid down for the accurate production of these parts in large quantities, and the work will stand favourable comparison in finish and accuracy to the finest clockwork. It is not intended that the apparatus shall be at any time opened by the supply station officials, as all necessary adjustments and tests can be conducted without breaking the dust-tight sealing. We understand that in certain cases the Electrical Company are prepared to hire out their apparatus so that the total responsibility for its continued working rests upon the makers.

* * *

TESTING LARGE ALTERNATORS.

AN improved method of testing alternators, devised by Mr. W. E. Burnand, is described in the *Electrical World and Engineer*. In this method the armature circuit is divided into quarters, as in Fig. 1, so that the E.M.F. of two quarters opposes and balances the E.M.F. of the other two quarters, and an alternating current is circulated through the armature from an external source of the same frequency as the machine under test, and whose phase with relation to this machine may be readily adjusted. This external source may consist of a small alternator with the same number of poles as the machine under test, and coupled to the same shaft; or it may be a machine of a different number of poles, driven from the shaft through gearing. This machine may be in circuit with the large one, either direct or through a transformer, and need only be of a size capable of supplying the electrical losses in the large generator and connections. By this arrangement practically all the effects of full load can be reliably simulated. The auxiliary alternator can be driven so as to circulate a current of leading, lagging, or any desired power factor. The heating and regulation can, therefore, be determined for any of these conditions. The efficiency can be determined from the balance of power required to drive the machine at its working speed with full load current circulating through the armature, after subtracting the power lost in the outside connections, the auxiliary alternator and the gearing driving it. Fig. 2 shows the manner of testing the regulation of the machine, the voltmeter and power factor indicator being in connection with the half of the machine in which the current flows in the direction of the E.M.F.; the frequency meter being connected at any convenient place. A reading is first taken with no current passing through the armature; afterwards a reading is taken with full-load current passing, the power factor of which can be regulated by causing the auxiliary alternator to lead, lag, or keep in phase with the E.M.F. of the machine under test, the amperes being adjusted by a rheostat in the field of the small alternator. Assuming the speed to be kept constant, the difference in the two voltmeter readings gives the drop in half the armature. If the machine is designed to work with the armature coils all in series, the regulation is double this value, and if the two halves are to be in parallel the regulation is direct as given by the voltmeter readings. Should it not be possible to regulate the speed to that of the machine when unloaded, the effect of the variation can be calculated from the difference in frequency—the E.M.F. being proportional to this at constant excitation.

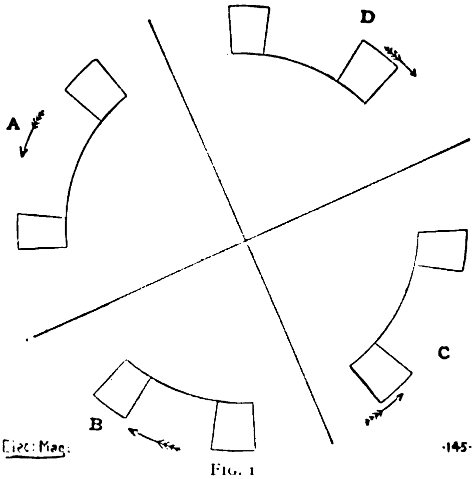


FIG. 1

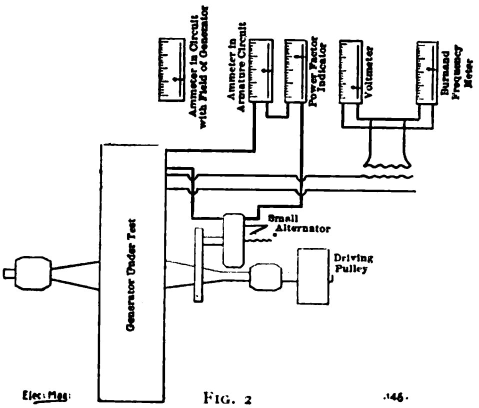
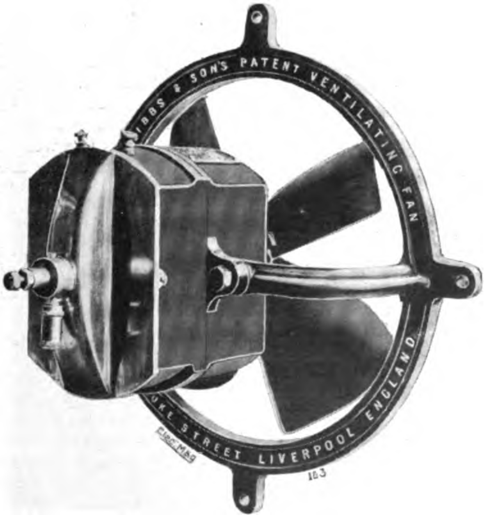


FIG. 2

A NEW MOTOR VENTILATING FAN.

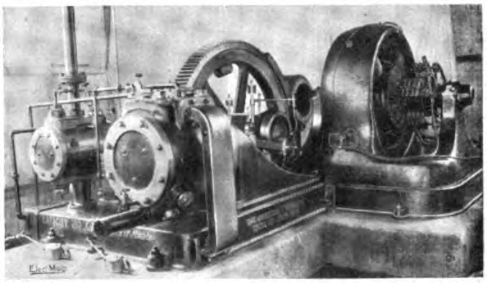
THE silent and efficient ventilation of small apartments has long been a difficult question, and many of the small fans applied for this purpose are anything but satisfactory. The 12-inch motor fan recently introduced by Messrs. John Gibbs & Son, of Liverpool, seems to be excellently adapted for ventilation, and we learn from the makers, that its employment has been attended with particularly successful results. The motor is of the smallest possible dimensions, consistent with working at a low temperature, for the power required. The fields are built up entirely of soft iron laminated plates, and the armature cores—of the slotted type—are also composed of laminated iron punchings carefully annealed, while each armature coil is thoroughly insulated and protected. Particular attention has been paid to the design of the brush-holders, so that the renewal of brushes and cleaning of commutators is a most simple operation. The bearings are specially adapted for running with either a vertical or horizontal spindle, and are fitted with cast steel balls. Lubrication is effected either by automatic solid grease lubricators, or by oil wick lubricators, according as the machines are run vertically or horizontally. The motor is entirely enclosed in a cast metal case, rendering it practically water and dust tight. The fan blades are built into a Gibbs patent boss, consisting of a double boss locked with flanges in such a manner as to perfectly grip the blades so that they cannot fly out. This improvement deserves the careful attention of fan purchasers. Finally, we may point out that the motors and fans can be detached instantly from the foundation rings, and, if required, attached to rings provided in other positions. This feature should be especially useful when the fans are used on steam ships, as they can be moved from place to place with great facility.


BBS & SON'S PATENT VENTILATING FAN
KE STREET LIVERPOOL ENGLAND
ELEC MAG
163

MOTOR FAN.

MOTOR DRIVEN AIR COMPRESSORS.

AMONG other useful types of electrically driven air compressors made by the Ingersoll-Sergeant Company, one illustrated on this page deserves notice. This is a compound type of compressor with piston inlet cylinders varying in capacity from 81 to 1,205 cubic ft. of free air per minute. The machine comprises a substantial base upon which the compressor and the motor are mounted in such a way as to insure accurate alignment, smooth running, and very small wear on the gear and bearings. When desired, this type of machine can be furnished with silent running chain drive, and for varying air requirements automatically controlled electric drives with air-compressor controlled starting devices can be adapted as necessary. Some features of the piston air cylinder used in the Ingersoll-Sergeant compressor are worthy of notice. The two inlet valves are situated in the piston and, with the tube, are carried backwards and forwards with the piston. The valve on that face of the piston which is towards the direction of movement is closed, while that on the other face is open. This arrangement is particularly suitable for forcing out the compressed air from one end of the cylinder, while taking in free air at the other. When the piston has reached the end of its travel, there is naturally a complete stop while the engine is passing the dead centre, and an immediate start in the opposite direction. The valve which was formerly open is then instantly closed. There is no reason why it should remain open beyond this point, and it is closed at exactly the proper time by it own weight. The valve on the other side is left behind the piston, and the free air is admitted to that end of the cylinder for compression on the return stroke. No springs are necessary and there is no throttling of the incoming air, and no clattering or hammering such as is noticeable in connection with the use of poppet valves. The fly-wheel and the crank revolve at a uniform speed, whereas the movement of the piston gradually increases in speed from the start until the crank has reached the half-stroke position, when it gradually slows up until the crank is on the centre, and at this moment the valve gently slides to its seat. These inlet valves are as positive and as prompt in their movements at low as at high speeds.



MOTOR DRIVEN AIR COMPRESSORS.

ELECTRIC PUMP.

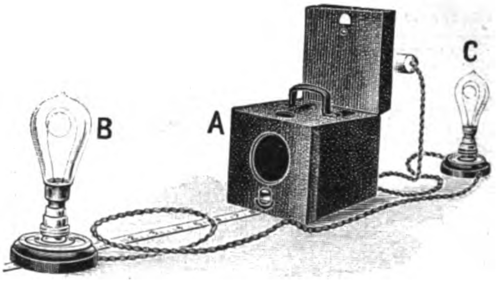
ELECTRICALLY DRIVEN PUMP FOR HOT WATER.

A USEFUL type of pump intended for hot water has been introduced by The Lahmeyer Electrical Company, of New Oxford Street, London. As shown in the illustration reproduced on this page, the motor is situated at some little distance from the pump, so that it may not be prejudicially affected by heat. The pipe upon which the motor is mounted is about 7ft. 6in. long, the motor being fixed at its upper extremity, while the pump is bolted to a flange at the lower end of the pipe. The motor has an output of 28 h.p. at 230 volts, and runs at 500 revolutions per minute. The motor is of a standard design, and either an alternate or a direct current type can be used with equally good results. It is also possible to dismantle the motor very quickly, should adjustment or repairs be needed.

LAMP TESTING INSTRUMENTS.

Useful Aids to Lamp Buyers.

THE Lamp Testing ammeter recently introduced by Messrs. Everett, Edgcumbe & Co., is essentially an accurate low-reading ammeter fitted with lamp-holder, adapter, and fuse, in using which it is merely necessary to insert the lamp to be tested in the holder, and to place the adaptor in the socket from which the lamp was removed. The lamp will then light up, and the current consumed can be read from the dial. To save all calculations, a lamp testing wattmeter has been introduced by the same firm. This instrument is very similar to the lamp testing ammeter, except that its indications give the actual watts consumed irrespective of the voltage of supply. Readings can be taken very rapidly on both instruments, and they can be used for direct or alternating currents with equal accuracy. Unfortunately, as our readers are aware, many lamps marked "16 c.p." are found, when tested, to give only 10 or 12 c.p. To afford reliable methods of testing lamps, Messrs. Everett, Edgcumbe & Co. have devised an extremely ingenious little portable photometer, illustrated on this page. This appliance consists of the photometer box, A, and two lamp-holders containing lamps, B and C. A standardised lamp is inserted in one of the lamp-holders, and the lamp to be tested is moved backwards and forwards along the graduated tape, until a small spot of light is just seen to disappear when viewed through the round hole at the top of the box. The candle-power of the lamp to be tested can then be read from the tape without any calculation. By a simple device the effect of extraneous light is rendered quite innocuous, so that measurements can be made in an ordinary room, and even in broad daylight. Changes of voltage also fail to produce any effect on the results, so that ordinary supply current can be used for carrying out tests. This apparatus may be obtained at a very small cost, and will be found very useful to purchasers of glow lamps.



PORTABLE PHOTOMETER.

HIGH POWER WESTINGHOUSE-PARSONS STEAM TURBINES.

WHEN the Westinghouse-Parsons steam turbine was introduced in the United States, the largest sizes built were not of more than 600 h.p. capacity, direct-connected to 400 K.W. generators. Subsequent development has been rapid, and turbo-generators of 5,500 K.W., or 7,500 h.p. nominal capacity, are now under construction. These machines have a continuous over-load capacity of 11,000 h.p. in one self-contained unit, and thus rank among the largest prime-movers in the world. The distinguishing features of the latest type are extreme compactness and low speed. The space occupied by a 7,500 h.p. turbine is approximately 27 ft. 8 in. by 13 ft. 3 in., and the height at the top of the hand-rail is 12 ft. This is equivalent to 0·049 sq. ft. per h.p., or 20·2 h.p. per sq. ft. of floor area. For the complete unit an area of 47 ft. 4 in. by 13 ft. is required, equivalent to 0·084 sq. ft. per h.p., or 12 h.p. per sq. ft. of floor space. A graphical comparison of the floor area required for different types of prime-movers is shown in the diagram on the next page, a complete unit being taken in each case as the basis of comparison. This point of relative economy of space is well illustrated by Fig. 2, which represents in

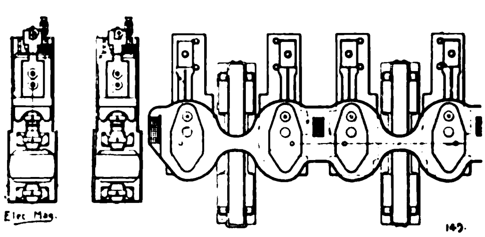


FIG. 2.

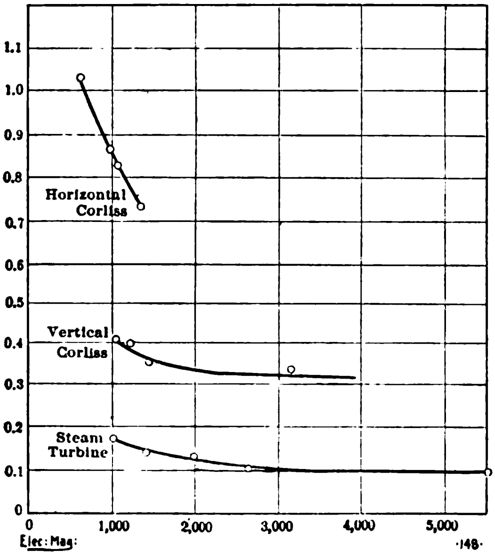


Diagram Comparing Floor Space of Different Prime Movers.

plan the comparative space occupied by the 5,000 K.W. Manhattan Railway engine units, and the 5,000 K.W. Westinghouse-Parsons turbine units. Machines of the latter type will form the initial equipment of the Pennsylvania Railroad Terminal in New York. Three similar units will similarly inaugurate the power service on the Philadelphia Rapid Transit Subway system now under construction, and, as our readers are aware, several large units are now being built for the District Railway and other systems in London.

A NEW LOCK PUSH SWITCH.

The Hart & Heheman Manufacturing Company, of Hartford, U.S.A., are placing on the market a new push switch which is worth attention. The switch is intended to be operated only by a person having a key. Fig. 1 is a plan showing a portion of the mechanism. Fig. 2 is a view of the switch blade, bottom side up. In assembly, the switch blade would be turned over, the hole p, in Fig. 2, fitting on the shaft p, in Fig. 1, the slide u, in Fig. 2, engaging with the pin v, in Fig. 1. Referring to Fig. 1, the parts g form a kind of toggle joint, the pin v working in the slot u. All these are fastened rigidly together, and held in tension by a spiral spring s, working on the shaft p. Both ends of this spring press on either side of the fingers w, projecting upward in Fig. 1, and t projecting downwards in Fig. 2, which work one inside the other, the motion of t being limited by the slot s; and the motion of w by the stop r in the slot c. The lever g has a lip d projecting downward at one end. This lip rests against the guards m and n, which are turned on the portion C, and slotted at a, b and c. When the key is inserted in one of the buttons, it is pressed against a stud k' on the link l' This turns the part C to the right. The finger t is stationary as long as the lip d is restrained from moving the guard n. The finger w moving with the part C puts the spring on the tension, the other end of the spring being held by t. When the part C is turned as far as it will go to the right, the lip d escapes at the guard c, pressing back of it and out at a; then resting against the guard m. As soon as the lip escapes the guard, the spring is released, and the blades D fly over, opening or closing the circuit, as the case may be, by passing into engagement or out of engagement with the switch jaws. The same cycle of operations is performed if it so happens that the key must be inserted in the other button. The switch blade D is made of one continuous piece of brass, insulated from the mechanism by sheet mica. This apparatus is contained in a porcelain box. The wires are brought up outside the porcelain, and ample room is made for contact.

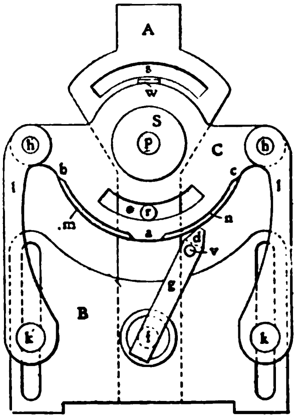


Fig. 1.

*

THE "CALLENDER-WARD" FUSE BOX.

In the new type of house-service fuse box made by the Callender Cable and Construction Company, there are several features of interest to central station engineers. The appliance is not only a fuse box, but a combined switching arrangement with fuse gear. Thus, by opening the lid, current is switched off from the installation, and by shutting the lid, the switch contacts are closed. In the type intended for the three-wire system, the neutral wire solid-link connection is attached to the centre of the porcelain bridge carrying the fuse for the outer, and is attached to the lid, so that when the lid is open, the fuse and solid-link contacts are brought up with it. By this means, the fuse can be renewed without the necessity for touching any of the live conductors. When put in position on the lid the fuse is enclosed in a chamber made of non-hygroscopic and non-flammable material. The fuse chamber is amply ventilated, so that when the fuse blows there will not be so much tendency for the arc to be maintained as is the case where the volatilised metal cannot mix freely with air. The box has been designed so that the fuses are always horizontal, thus minimising the risk of maintenance of the arc when the fuse blows. It is made as a double-pole fuse box by dispensing with the solid neutral link, and placing two fuses across the porcelain bridge.

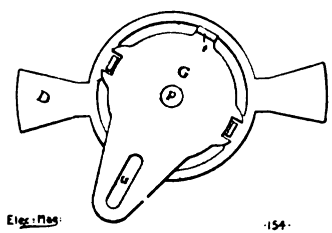
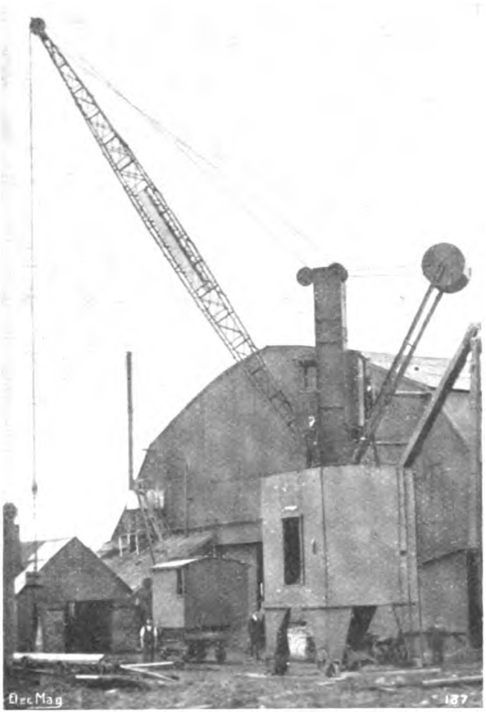


Fig. 2.

DOCK LUFFING-CRANES.

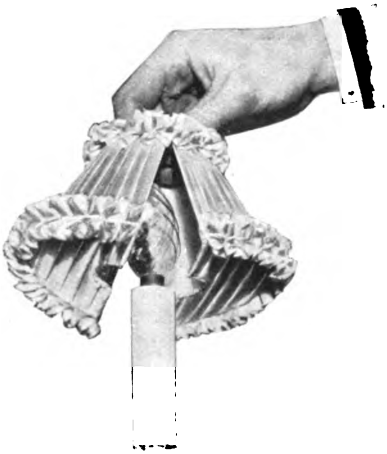
The illustration we reproduce on this page shows one of two electrically operated luffing cranes for dock use recently built by Messrs. Wimshurst, Hollick & Co., of South Fambridge, Essex. One of these two cranes has a capacity of 30 cwt., hoisting at a speed of 200 feet per minute, and slewing at 390 feet per minute. The maximum radius is 50 feet, and luffing can be effected from 50 feet radius to 20 feet, in about 30 seconds. The other crane is capable of hoisting 3 tons at the rate of 100 feet per minute, or 30 cwt. at 200 feet per minute, and of slewing at 235 feet per minute. The maximum radius with 3 tons is 30 feet, and with 30 cwt. 50 feet, and the appliance will luff from 30 feet radius to 15 feet in 30 seconds. Both of the cranes are worked by electric motors adapted for current at 410 volts.



Electric Dock Crane.

A NOVEL LAMP SHADE.

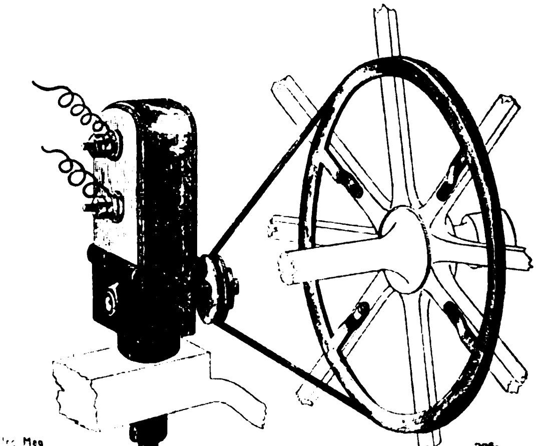
This patent shade, introduced by F. Parks, 26 Nassau Street, Mortimer Street, W., of which we gave a brief notice in our last issue, seems to supply a long felt want in electrical circles. It minimises the trouble and risk of breaking lamps, and considerably reduces the time now taken to adjust any of the existing forms of shade. With candle fittings and electroliers, one of the greatest drawbacks to the old method of fixing was that, however carefully shades were adjusted, they would never retain their upright position for any length of time. This disadvantage is now entirely removed by the patent shade illustrated herewith. It can be seen in a variety of patterns at the show rooms at the above address.



Shade being Placed in Position
(Notice one hand only required.)

SPEED INDICATORS.

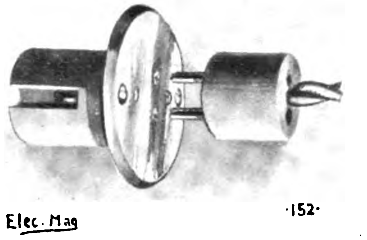
Messrs. Geipel and Lange are introducing a novel speed indicator. Simplicity is its chief feature, in that it comprises a driving pulley, a small magneto, and a hot wire volt-meter calibrated to read in miles per hour. The pulley is fixed to one of the driving wheels (preferably to the front), and the magneto, weighing but 1½ lbs., is driven by a rubber band from it, the whole arrangement being entirely woterproof, in fact, a hose can be turned on it. The adjoining illustration will give an idea of the magneto and pulley. The indicator is 2 inches diameter and weighs 3 ozs., and readings are equally accurate for either direction of the car.



Speed Indicator.

A NEW WALL PLUG.

The accompanying illustration shows a device lately put on the market by the Marshall-Sanders Company, of Boston, and known as the Junior Midget Plug and Receptacle. In this fitting a metal lid or hinge closes over the contacts, and the connection is made through two insulated holes in the plate. The plug and receptacle can be used in nearly all places where temporary connection is required, except in floors.



Measuring Instruments.

Some French Novelties.

A recent article in *L'Electricien* deals with various features of interest in electrical measurements, and gives detailed descriptions of several new instruments devised by M. Richard, of Paris. Among these we may mention an electro-magnetic ammeter, in which aperiodicity is completely attained by an "amortisseur," consisting of a light plate working in an air chamber. By reducing to a minimum the play between the chamber and the plate, absolute aperiodicity is said to be obtained. Other new forms of electro-magnetic ammeters and voltmeters are described, these being less accurate and characterised by the author as instruments of "demi-precision." They are, however, much lower in price, and are said to be more reliable than ordinary instruments for similar purposes. A new pattern of registering voltmeter and ammeter was illustrated, the only feature of novelty being that the instruments are more convenient than previous types for fixing on switchboards and elsewhere. Referring to electro-dynamic wattmeters for three-phase currents, the writer points out that if the phases are unequally charged it is necessary in the ordinary way to employ two separate wattmeters, but that M. Richard has avoided this drawback by the introduction of a combined wattmeter, in which the results are recorded by a single needle. The new thermal ammeter, designed by M. Richard for alternating currents, is furnished with a transformer instead of the shunt commonly used. For continuous current, the shunt is a necessity, but for alternating currents the transformer is in every way preferable, and for high tension currents is essential. The writer also describes a new phase indicator, and another indicator, showing the direction of energy and sounding a bell as a warning of desynchronisation. This apparatus is really complimentary to the phase indicator mentioned above, as it enables the operator to judge the most suitable time for connecting the alternators to be coupled.

German Electrical Industries.

A FRENCH OPINION.

In a recent communication to the Société des Ingénieurs Civils of France, M. L. Sekutowicz deals with the development of the German electrical industries. Passing in review the seven great manufacturing concerns of that country, he discusses their constitution, general organisation, works equipment, and financial history. He then directs attention to the important part which the export trade has always played in the development of electrical manufacturers in Germany, and referring to the financiers who were useful at first in fostering the infant industry, he shows that they have since been the direct instigators of over-production, and are to be held directly responsible for the recent crisis. H. Sekutowicz brings forward evidence to demonstrate that this crisis was practically confined to financial circles, and that its effects were scarcely felt by the nation as a whole. He next considers the influence of the crisis upon the industrial companies, adducing figures relative to the actual effect upon their financial status, and providing that although prices were seriously depressed, there was no diminution of output, and that during recent months production has been very materially increased. Finally, dealing with the consolidation of the electrical industries commenced in 1903, the author says that the amalgamations of the Societies Allgemeine and Union, and of the Societies Siemens and Schuckert are not merely financial operations, but also involve the reorganisation of the several works, and the introduction of highly specialised methods of manufacture. Although admitting that the amalgamations have not yet resulted in any material increase of price, he thinks there is every reason for believing that the present movement will culminate in the incorporation of all the electrical manufactories in one huge trust. Having cited the many directions in which electrical energy has been utilised in Germany, the author hopes that French firms will devote attention to this important branch of industry before the Germans become too firmly established. He discusses the possibility of the export trade in Germany being destroyed by future commercial treaties, and adds that the German makers are already seeking to insure themselves against such a contingency, and expresses the opinion that the working arrangement recently made with the General Electric Company, of America, is virtually the first step towards the establishment of an International trust for the control of the electrical industry. The author concludes by saying that French manufacturers have now an opportunity of regaining lost ground, expressing the hope that, by means of industrial combination and judicious equipment, his countrymen will equip themselves for successful competition with the foreigner not only in French colonies, but in all the markets in the world.

* * *

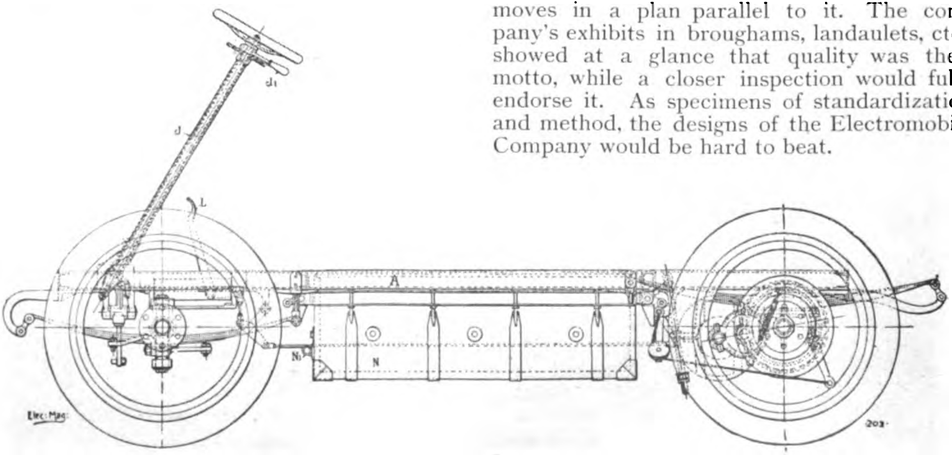
The Review Section this month contains a number of reviews of books, which every manufacturer should read.

Electricity at the Crystal Palace Automobile Show.

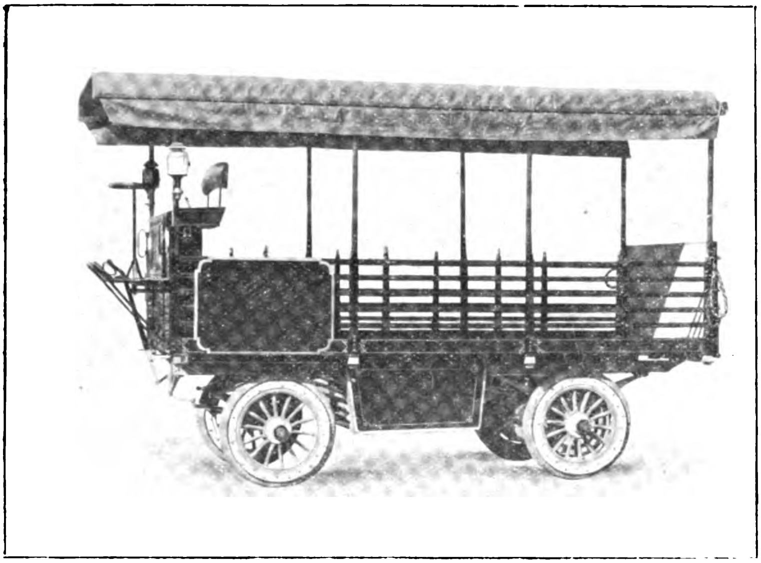
Electricity must at present content itself with playing a secondary, though none the less important, part in the development of road vehicles, and this proprietary interest—if it may so be called—must be regarded as the germ of its ultimate expansion over the entire field now held by petrol driven automobiles. The electrical exhibits at the recent Crystal Palace Show were not remarkable for any epoch-making device which should hasten the general employment of electricity for road traction, though there are distinct signs of activity in the battery world. Ignition devices are experiencing marked improvements, and efforts are being made to introduce, both for cycle and car, magneto generators, and not without considerable success. The electric landaus, broughams, and victorias—common enough in London streets—were much in evidence, though no striking changes have been made in their construction. The lighting of the stands was a distinct feature of the show, and reflects creditably on both the system and the work of the contractors—Electric Lighting Boards, Ltd. Although it is disappointing to find progress in accumulator development so slow, it is encouraging to notice some movement and not stagnation. The exploitation of the petrol-electric combination for car work will probably pave the way for the all-electric vehicle, and drivers will thus gain an experience of accumulators which would otherwise be denied them. The electric car will thus creep into the place of its petrol rival, instead of ousting it at a bound. The advantage of an evolution of this kind cannot be over-estimated.

ELECTRIC VEHICLES.

The Electromobile Company made a fine display of their vehicles, the chief feature of which was a C spring victoria. Throughout the entire range of vehicles made by this firm one type of chassis only is used. This is known as the "straight chassis" with "underslung interchangeable battery." Reference to the adjoining outline will explain the disposition of the various parts. The cells are assembled in a single box slung under the frame between the wheels, assuring interchangeability, even distribution of weight, freedom from side slip and accessibility. This position enables the cells to be removed and recharged (at the depôt) apart from the vehicle, consequently a more complete inspection can be made than when charging goes on *in situ*. The 44 cells are of the "Contal" special pasted type, and weigh 10 cwt. On one charge the victoria can be driven 40 miles and the double landaulet 30 miles. The positive plates have about 12 months life, and can be quickly renewed at low cost. One motor of 8 h.p. at 1,800 revolutions drives the vehicle through a double train of double helical gearing. It is bi-polar series wound, with two communtators and two armature windings. M.M. Contal and Gosnier, the designers, have introduced special field castings and bobbins, which dispense with magnetic joints and avoid field distortion due to armature reaction. Greenwood and Batley are the makers. The controller gives forward speeds from 3-15 m.p.h., two electric brakes, and one reverse speed. The handle is directly below the steering wheel and moves in a plan parallel to it. The company's exhibits in broughams, landaulets, etc., showed at a glance that quality was their motto, while a closer inspection would fully endorse it. As specimens of standardization and method, the designs of the Electromobile Company would be hard to beat.



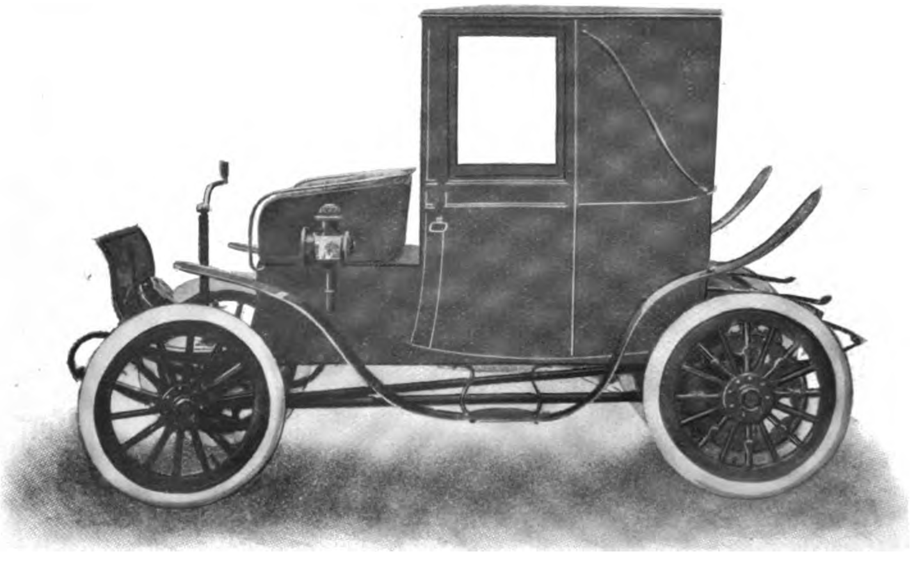
Standard Chassis.
(Electromobile Co.)



Electric Delivery Truck.
(Anglo-American Motor Car Co.)

The Anglo-American Motor Car Co., Ltd., among an extensive exhibit of petrol cars, were showing several of their electric vehicles—a victoria, stanhope, and runabout. We illustrate herewith, a delivery truck, which was crowded out of the exhibit for want of space. The small cars are of the Baker type, very compact, and carrying, in the body of the runabout, only 12 cells. These are equal to runs of 60-70 miles on one charge. The victoria, with underslung battery, two 3-h.p. motors, and speeds to 14 m.p.h., is equal to a run of 40 miles. The delivery waggon, similarly equipped to the victoria, but with larger battery, is capable of running 30 miles on one charge with a load of 2 tons. Curiously enough, vehicles of this class are regularly plying in New York, but there are none running "on this side." The company will fit any make of cell the customer may fancy.

The Anti-Vibrator, Ltd., of Croydon, exhibited one of their latest designs of carriage employing a special frame which is stated to prevent the transmission of vibration. The cells are placed in this frame within the body of the vehicle. Two 3 h.p. motors operated from a special controller serve to drive the vehicles up to 14 m.p.h. The



Electric Carriage.
(Anti-Vibrator, Ltd).

batteries admit a run of 40 miles under average conditions.

Among other carriage exhibits were those of the London Electro-mobile Syndicate, and the Kreiger Electric Carriage Co.

ACCUMULATORS.

The N. S. Battery.

Of the Accumulator Exhibits the N. S. (Niblett Solid) Battery first claims our attention as possessing features not to be found in any other cell. Although little has been done in this country (or any other for that matter) to materially advance accumulator traction in whatever form, it is evident that genuine efforts are being made to produce a cell which shall fulfil the severe demands imposed by traffic conditions. In the N. S. cell the elements of the ideal are plainly evident, and though the traction form is not yet fully developed, we were assured by Mr. Niblett, who kindly explained the entire process on our recent visit to his works at Horton Kirby, Kent, that experiments are now proceeding in which the present type will be materially lightened for the work in question. In Fig. 1 a section through the cell fully explains its design and component parts. Essentially, these comprise a wooden case lined with lead, serving as the negative electrode; a positive electrode of lead in circular form with many grooves to increase the surface; a circular porous pot; and the active material. The latter is made up in the shape of pellets or small cylinders, and disintegrated lead, and is packed firmly into the spaces between the positive and negative electrodes and the porous pot. A nut and washer at the top of the positive electrode securely clamps the active material in the porous pot. The extreme porosity of the elements admits of the absorption of the electrolyte, and should the cell become overturned, leak, or in any way lose its liquid, it can still be worked up to half its capacity without injury. An examination of the section at once makes it evident that the cell will bear very rough treatment, and that internal short circuits cannot be produced by any displacement of the active material. Buckling also, the chief drawback to a plate cell, is impossible, consequently the cell can be short-circuited with impunity. The E.M.F. of each cell after charging is 2·2 volts, which falls to the normal 2 volts. On discharge a reduction to 1·7 volts for lighting, and 1 volt for traction circuits being quite permissible. Up to 95 per cent. quantity efficiency and 70 per cent. energy efficiency has been obtained from the cells; in the largest sized cells 4 watts per lb. of complete cell is their present capacity, but the makers in their traction cell hope to raise this to 10 or even 12 watts. In the brightest accounts of the latest Edison cell 11 watts per lb. was regarded as a remarkable figure. A feature of the solid cell is the increase of its capacity with use, this being due to the more complete forming of the elements. The enormous exposed surface of active material, both positive and negative, admits of very high rates of charge and discharge without injury to the cell. Excessive discharges leading to expansion

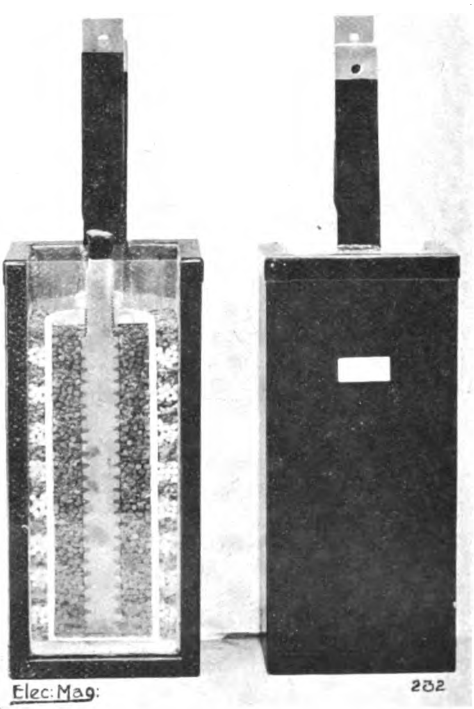
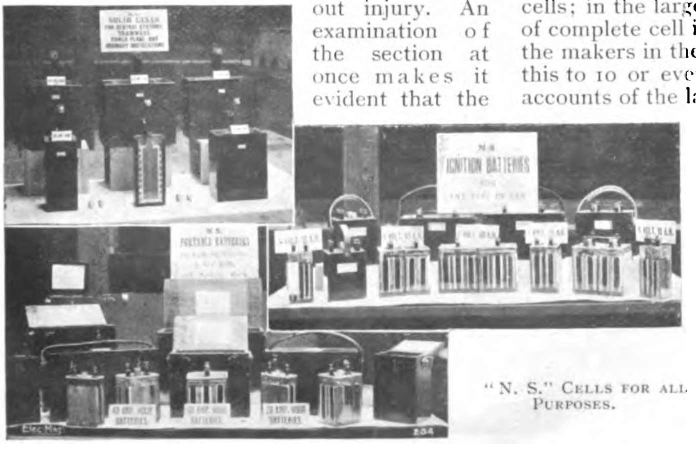


Fig. 1. "N. S." Solid Cell.



"N. S." Cells for all Purposes.

and disintegration could only result in the settlement of the material at the bottom of the cell and would do no harm. Contrary to the impression which has hitherto prevailed, it now appears to be proved beyond doubt that the interposition of porous separators need not appreciably increase the internal resistance of an accumulator cell. In the case of the N. S. Cell there is a considerable amount of free electrolyte on either side of the porous separator, and hence electrolytic action is not in any way impeded. Again, owing to the free circulation of the electrolyte on both sides of the porous separator, the sulphating does not occur which might possibly happen if the solution were imprisoned.

The same Company make a semi-solid cell both for petrol ignition and lighting purposes. This is formed of special grids, containing a large amount of active material, separated by special porous plates, the whole being clamped up solid by the outside negatives of the set. Cells of this construction are free from short circuits in that the paste cannot fall between the plates, the separators entirely preventing this.

The solid cell has every prospect of figuring prominently in the immediate development of electric vehicles, and even if its performance cannot yet be raised to one's idea of a perfect motor-car battery, there is room for any battery possessing the essentials necessary for traction work--simplicity, absolute freedom from internal shorts, reliability, and cheapness. The N. S. battery appears to possess these features, especially the latter, and we anticipate a big demand for the traction type, judging from the satisfactory results already obtained. Our readers need no introduction to Mr. J. T. Niblett, as his name has been associated with the battery business of the last twenty years. We shall hope to give detailed particulars and tests of the traction cells at a later date.

Longstreeth's, Ltd. (Lithanode Electric Storage) had a small stand on which were exhibited their lithanode high rate discharge batteries, ignition coils, and patent unspillable ignition accumulator with protected terminals. This latter possesses a small additional compartment into which the electrolyte spills, there being a vent for the escape of the gas. Our readers will recognise the word Lithanode as among the pioneer names in the accumulator world.

The Sola Accumulator Co. exhibited the Sola accumulator for traction purposes, together with smaller cells for ignition. For the traction cells the makers claim ability to stand heavy discharges without injury, while their capacity is also equal to long distance work. Messrs. Horners & Sons, Mitre Square, E.C., are the wholesale agents.

IGNITION DEVICES.

Simms-Bosch Magneto.

The Simms Manufacturing Co. have long been associated with magneto ignition, but until recently their device generated low tension currents, necessitating a mechanical brake in the cylinder. By the introduction of their "Arc Light" magneto ignition they can utilise the ordinary H.T. spark plug and dispense with the lever motion to produce the spark mechanically. Several interesting models were on view at their stand, the device being suitable for both motor cycle and car. The reciprocating motion of the earlier L.T. ignition gives place to a rotary motion produced either by chain or belt. Fig. 1 is a diagram in which the permanent magnets are inverted for convenience in exposing the connections. The armature, A, is stationary, and provided with windings, A^1, A^2, the former of stout wire and the latter of thin wire, corresponding to the primary and secondary respectively of an induction coil. One end of A^1 is earthed to the machine shaft, and A^2 forms a continuation of the primary. The other end of A^1 is coupled to one side of contact breaker, B^3, and to one terminal of the condenser, the other end of the latter and the moving arm of B^3 being earthed. A soft iron sleeve, B, is rotated to produce the changes in magnetism necessary to the production of the primary alternate current. B^1 is a hollow shaft, carrying the sleeve and the notched disc, B^2, and also the H.T. distributing disc, D.

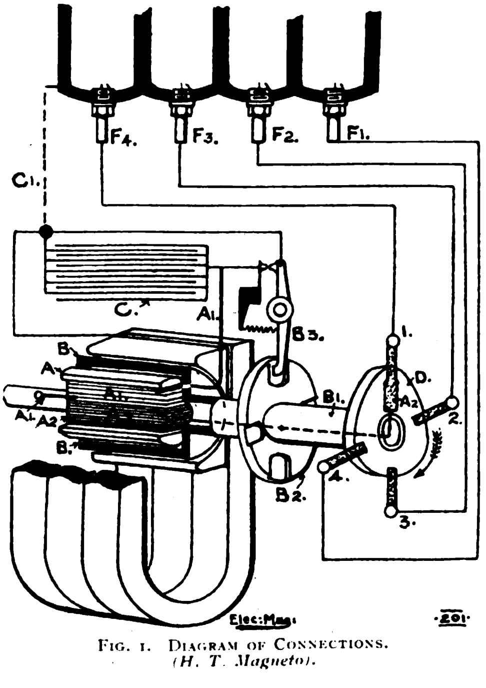


Fig. 1. Diagram of Connections.
(H. T. Magneto).

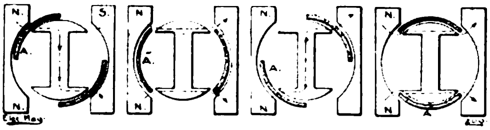


Fig. 2.

The action of the sleeve is explained by Fig. 2, which depicts the magnetic changes of one half revolution. In position 1 a maximum of lines of force pass through the armature, and no current is induced in the windings. In position 2, moving through 45° from right to left, the segments short-circuit the magnetic line, and a current in one direction is induced in the windings. Positions 2 and 3 correspond in principle to Nos. 1 and 2, but current is induced in an opposite direction. Four times in each revolution the current reaches its maximum value. The faster the sleeve rotates the stronger will be the induced current.

The rotation of the contact disc, B^3, causes the interruption of the primary current at the right moment, the condenser, C, giving the necessary "kick" to the E.M.F. induced in the secondary. The spark plugs, F^1, F^2, etc., are consecutively inserted in the circuit by the contact strips on disc, D.

The L.T. ignition was also shown in action, and, we were assured, would still find a field in spite of the introduction of its less complex brother described above.

Messrs. Peto and Radford were well housed on a well designed stand, and exhibited almost everything conceivable in batteries, small lamps, coils, spark plugs, charging dynamos; in fact, the complete requisites for battery ignition. The electrodes of their latest type of ignition cell need no special description, as they are the pasted grid kind, which they have so long successfully employed for this class of work. The novel feature of the cells lies with their electrolyte, which, instead of being in the ordinary liquid form, consists of a semi-solid mass, produced by saturating pure lead sulphate with dilute sulphuric acid. This stiff paste is filled in between and all around the electrodes, so that they are entirely embedded and formed into practically a solid block. The mechanical advantages of this arrangement are obvious. The electrodes are firmly held in their proper position, no matter how much shaking and jolting they may receive; nor can their active material fall away and produce short circuits by bridging from plate to plate, or lodging on the supporting pieces at the bottom of the cell. At the same time, so well does the lead sulphate retain its fluid content, that the outer case of the cell may be entirely removed without, for some time, interfering with its working, and the charging and discharging can be carried on as usual until the evaporation of moisture into the air causes the paste to dry up and lose contact with the electrodes. Although this experiment has been actually carried out, a contingency is not likely to arise in practice; but the same property comes into play should the cell be damaged or fractured, and, should it be accidentally upset, not a drop of liquid will be spilled.

Some yet more important advantages are claimed by the makers of this type of cell. They find that when left idle for considerable periods, it will retain its charge far better than a similar cell containing the ordinary fluid solution, and that on discharge its voltage keeps almost to its maximum value right up to the end. They do not pretend to be able to explain how these results come about, but think it is in some way due to a prevention of sulphating in the plates. Experiments with larger cells made up in a similar fashion are now in progress.

An interesting novelty is their terminal protector, a device which should make a driver forget his accumulator entirely. A vulcanite cap, in which the terminal nut and insulated connector are embedded, comprise the device, which affords complete protection from attacks by acid.

G. T. Riches & Co. had an extensive exhibit of ignition appliances, chief among which was the Eiseman magneto ignition for both cars and cycles. This comprises a rotary magneto machine, gear or chain driven from the engine shaft, and furnishing high tension current through a coil to the usual sparking plug. The weight of the cycle and small car type is 13½ lbs., but this is increased to 30 lbs. for a four-cylinder engine. Each igniter is fitted with a commutating device which changes the a.c. generated current to continuous current supplied through the coil to the sparking plug.

The Electric Battery Co. had a good showing of their specialities in batteries, coils, sparking plugs and the usual accessories of electric ignition. The grids of the company's cells are built with staggered bars which securely interlock the paste and prevent disintegration. Short circuits and loss of capacity are therefore entirely avoided; a speciality in coils is a high speed type with Carpentier contact breaker.

* * *

Stand Lighting at the Show.

The lighting of the various exhibits was a pleasing feature of the exhibition. Some 10,000 8 c.p. lamps were installed in three days on upwards of 150 stands, as well as a large number of motors for driving models. The temporary plant comprised four direct-coupled sets and two belt driven. The stand wiring was carried out with Electric Lighting Boards' "Elblight" system, employed at the recent Paris automobile show, and we understand that it will also be used this year at St. Louis.

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

Central Station Organisation.

By the ASSOCIATE EDITOR.

Second only to safety and a reliable supply comes economy, in the category of engineering virtues, and the great aid to economical production is organisation. A place for everything and everything in its place should be insisted upon in season and out of season, until it has become second nature in all employed, whether in a superior or inferior capacity. Perhaps the enforcement of the rule should be effected more by example than precept. "Show me the office boy, and I will tell you the character of the chief engineer," was the text of an address to a body of engineers, and the writer of these words found his audience responsive to the suggestion. Another engineer amused himself some years ago by penning a booklet on "human dynamics," which has puzzled more brains to get a conception of what it was all about that copies have been read and appreciated at true worth. These are indications of what principals in all branches of business know so well; no amount of persuasion or fault-finding has the same effect as masterly leadership. A junior will unconsciously follow an example where he will fail to abide by the rules drawn up for his guidance. Upon what lines then should the central station be managed?

Here one may look aside for a moment at the executive bodies carrying out large works, whether these are profit-yielding or not does not ultimately affect the question. The reorganisation of the War Office is a good example. With centuries of experience and vast interests at stake, it has been found necessary to apply the principle of decentralisation where before the reigning ideal was centralisation. Many are the tales contractors tell of the stone wall attitude of the officials at Pall Mall, when an attempt had to be made to find out exactly what articles were required in an electrical contract. Sent from one office to another, kept on the move with no apparent end to his wanderings, the representative to whom the task was allotted was made to feel the utter impossibility of finding one authority whom he had to satisfy. How far removed from this is the attitude of large business concerns which have been built up in a few years from a mere nothing to splendid examples of foresight and method. One important contracting company has deliberately worked on the principle of each of its staff having full control of his own methods when work has once been given to him; the results being judged accordingly, as they are favourable or unfavourable. "Progress by results" is all very well if reasonably unfettered management be granted to the one who has to attain these results, but if limitations be set in every direction the human element involved is discounted. Either responsible officials must be invested with authority and left to show results, or they must be given certain definite lines upon which to work, and heed only negligent if they fail to carry out the instructions given.

Municipal bodies do not often realise that their officers must be given reasonably unfettered control if they are to be held responsible for results; or, if guided, instructed, and hedged round with ideas not their own, the officials must be judged by the loyalty with which they obey, and not by the outcome of that obedience. This is the key-note of municipal management. Officials must be "red-tapey." If they fail to recognise this, they cannot help transgressing some of the written or unwritten laws that have grown up around the corporate ideal. All this is apart from the rightness or wrongness of municipal trading from an ethical standpoint. It affects the servants of the municipality more than the collective body, which, while paying the piper, nominally calls the tune.

Assuming, then, that the responsible head is an individual invested with due authority to maintain his office, he must delegate a large portion of the executive work to others. The functions of a chief engineer are essentially administrative, and when one hears of men in this position who have given vent to their feelings by suggesting that, if they had been "there" things would have been better managed and wrongs put right more expeditously, a feeling of sympathy, mingled with a spice of cynicism, that such a mistake should have been made, must be created. "There," for the time being, may be a breakdown inside or outside the works; then the officer, whose detail duties require him to put things in order, should be capable of doing so, and if not so capable, he proves his unfitness for the post he ought to grace. The selection of his staff is the test of the chief engineer, and a very great deal, if not everything, depends upon the manner in which this first of all duties is exercised. Like our most successful generals, he must stay behind at headquarters, planning, thinking, foreseeing eventualities, guarding against surprises, and placing the right men in the front rank to lead, direct, and inspire the rank and file with confidence. Acting through others, himself unseen, but ever making his presence felt.

The mistake made by the beginner in organisation is to attempt too much himself. The manager should think for others, and leave those others to carry out his thinking to the fruition. A grasp of detail does not involve the constant tinkering with and dissipation of energy that comes from continual association with details. The less comprehensive mind is better fitted to a close contact with the petty things of a business department, for as the vision is restricted, so does the magnitude of each item become enhanced. But to every unit in the whole definite work should be allotted, and nothing short of perfection should be tolerated in the manner in which it is carried out.

Much may be said respecting the relative functions of a chief engineer and his board or committee. This is rather too important to be dismissed in a few lines; but there is an axiom, without adherence to which we have seen no success in management: the manager or chief engineer should be paramount. Companies succeed better than municipalities in trading, because there is no divided counsel. They have but one end and aim against many, and often conflicting ones, in local government. As a company is formed for the purpose of making profits, it entrusts its head officer with the authority to organise solely to this end, and he selects subordinates capable of supporting him in the effort. This is the first and most important point.

THE REMOVAL OF FAULTS ON THE DISTRIBUTING SYSTEM.

This article is one of a series which will be presented monthly by the Associate Editor on mains work. Each instalment will be complete in itself.—[Ed.]

The importance of the distributing system to central station engineers is very great, for two reasons: Firstly, the apparatus is scattered over miles of streets; and, secondly, the outside plant can neither be duplicated nor reserves brought into use automatically, as can be done at the station. Distance in dealing with trouble on the network is in itself a difficulty. Another obstacle is the street boxes, for with pedestrian traffic, and at night the mains engineer has his work before him to conduct any repairs at all. A maximum of tact, good temper, patience, and no mean powers of rapid organisation must go together, if he is to get things put right with the minimum interference to his customers and the maximum of credit to himself.

A species of second sight is the next equipment that the head of a breakdown gang can possess. If, as we are told by psychologists, the brain can be trained to act in almost super-normal ways, it is an excellent thing to cultivate the ability to use a mental fault-divining rod, and by some process of intuition, rather than reasoning, go straight to the fault. Very good luck has been earned and deserved by a course of training of thought and habit, and by a systematising of the mental functions, which reduces haphazard to the product of a number of factors, whose result is seen without themselves being apparent.

The most valuable element in breakdowns is the knowledge possessed by the engineer in charge of the run of the mains. If he has the map of the system in his head, and from an intimate familiarity with all the details is able to arrive at some conception of what may have happened, and what could not have occurred, he will be self-reliant and inspire his working assistants with energy. The academic notions that find a place in the engineering journals must prove a source of harmless amusement to practical men. A short time ago a writer ventured the suggestion that it would be an assistance if plans of the mains were pasted on the inside of the lid of the breakdown tool chest. This sounds very pretty, but the absurdity of anything of the kind is evident. Assuming that ordinary plans of 10 ft. to the mile are prepared, how much of a supply area could be depicted on the inside of a tool box cover? The answer is left to the good sense of those whose acquaintance is not limited to the outside of a tool box. But as it is not sufficient to act the iconoclast, we substitute what has been proved a workable alternative. Let the mains staff be accustomed to record in their pocket-books the run of each main, the boxes on it, and the tappings taken off. Each page can then show something definite, the portion of network, say, fed from one sub-station in a particular direction, and, as the scale will not be a lineal one, but adopted to suit the different parts relative to the supply, the sketch diagram can be grasped by the owner in a fraction of the time taken to gain information from a properly scaled plan. But the diagram should even then bear the same relationship to the brain knowledge of the system that a pocket-book formula or table does to the science of which it expresses a truth. The engineer should be able, at a moment's notice, to sketch from memory the general lay-out of the mains; and this habit of memorising the salient facts of the system repays itself over and over again. Having the foundational knowledge of his plant, knowing where everything is and what it is, he can safely refer to a plan to refresh his memory, but goes ahead with the repairs without delaying or calling upon others to assist him.

There is one method of keeping a general record of connections which is very handy. Have a set of rubber stamps prepared with the diagrammatic representation of all box interiors, and, on being required to locate and eliminate a fault upon a given section, make a rough copy upon foolscap of the network, impressing upon the paper, in the positions they occupy, the various boxes, and join them up by pencil lines. The particulars can be taken off the full record plans in the office before setting out, and the few minutes spent enable a rapid survey to be made of the ground to be subsequently covered. The review of the local peculiarities may recall some almost forgotten incident that may explain what has taken place, and indicate the best points at which to break section and, if necessary, test.

Having got through the preliminaries, a start has to be made. Here, again, comes the divergence between the action of the theorist and the practician. When familiar with hundreds of faults, less reliance is likely to be placed upon tests than if fault-finding were a novelty, and a chance of experimenting with the extremely interesting methods of the lecture theatre and the text-book. What Mr. Wordingham calls the "unscientific and brutal method of trial and error" is held in greater respect by the engineer than any other. If a network be systematically divided up section by section and length by length, less time will be taken than if elaborate tests are at once proceeded with. The advantage of the "brutal" method is, that non-faulty sections can be re-connected and got on supply before the fault is found. *Eliminate the unknown and reform the equation*, is one way of putting it; *get rid of the majority and confine attention to the minority*, another.

It must not be gathered, from the stress we have laid upon the topographical aspect, that we fail to appreciate the value of electrical testing, or would minimise the benefit of proper means of localising when the fault has been reduced to a defect upon a main, the ends of which are accessible. But until the ground has been cleared of generalities, and a network has been split up into its components, the experience of the past few years has proved that *technical skill counts for less than local knowledge*. The place to learn how a thing is done is in the workshop, or in the field or on the street with the breakdown gang. If one had to commence the subject with a tyro, the best advice would be to urge him to use his eyes. Nine out of ten—probably ninety-nine out of a hundred—faults occur at joints or in boxes. Many have been located by the discovery of a dry spot on the pavement on a wet day, or, in more severe cases, by the (what the Philistine calls the "Manchester method") smoke and vapour rising from the leakage point.

ON THREE PHASE TRANSFORMER CONNECTIONS.

Three-phase alternating-current transformers may be wired in two ways. When high pressures are employed, the star connection is generally chosen, Fig. 1 being a diagram showing three transformers thus connected on a three-phase circuit. The primary coils of the three transformers are at *v*, *m* and *z*, and their respective secondary coils at *c*, *r* and *e*. Since there are two transformers between any of the line wires *d*, *f* and *b*, the line voltage is not subjected to any one primary winding. Whatever be the pressure between any two of the line wires, the pressure across any one of the primary coils *v*, *m* or *z*, will be but ·577 of that amount, while the pressures induced in the secondary coils will be governed by the ratios of the respective transformers. Whatever the value of the secondary pressure induced in each transformer this value will, if multiplied by 1·732, equal the pressure between any two of the secondary distributing mains. The value of the star method for connecting transformers together is now evident, for but little more than half the line wire voltage is subjected to each of the primary windings. The star method also possesses advantages over the mesh connection,

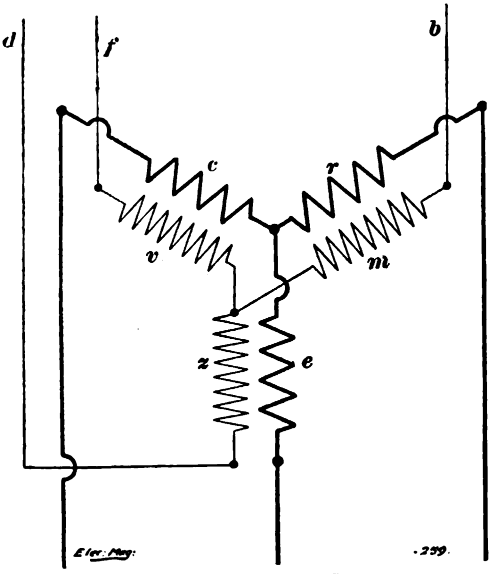


Fig. 1. Star Transformer Diagram.

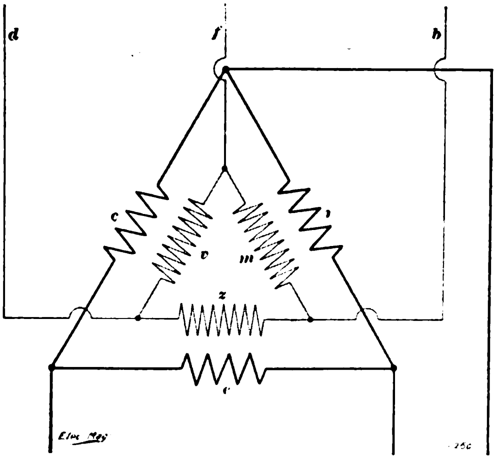


FIG. 2. MESH TRANSFORMER DIAGRAM.

when, for secondary distribution, a connection is made to the common junction of the secondary windings of the transformers.

As to the primary and secondary currents in this form of connection, each primary winding of the transformers is the same as that in the respective line wires between which it is connected. The value of the induced current in each secondary winding of the transformers is greater than that in the corresponding primary winding, in the same proportion as the respective secondary pressure is less than the corresponding pressure in the primary winding. In the secondary distributing mains the current is, of course, the same as in the secondary transformer windings connected thereto.

The mesh connection is more generally employed for three-phase work than is the star connection, unless for reason of the high pressures in use or on account of certain special forms of secondary distribution the star connection is particularly advantageous. In Fig. 2 is given the method of wiring three transformers in mesh connection on a three-phase circuit. To avoid confusion between the mesh and star connections, the similar parts in Fig. 1 and Fig. 2 are lettered the same; by this means there should be no difficulty in understanding the difference between the connections. If now there be a certain voltage between any two of the line wires *d*, *f* and *b*, the voltage across any one of the primary coils *v*, *m* or *z*, will be of the same value, while the pressures induced in the secondary coils will, as in the star connection, be governed by the ratios of the respective transformers. Whatever this secondary pressure in each transformer be, this same pressure will exist between any two of the secondary distributing mains. This subject was fully dealt with recently in *Electricity*, N.Y., from which the above is abstracted.

◆

***Important.**—The experiences of central station men are often of vital interest if presented to their confrères in concise handy form. Electricians, Shift Engineers, etc., are invited to send us particulars, data, details of break-downs, and repairs, which will be included in this section.*

CENTRAL STATION NOTES.

A Large Cable Conduit.

THE new power house of the Edison Electric Co., Boston, Mass., is fitted with cable conduits to the number of 96 in one trench, for leading the cables from the machines to the switchboard and thence to the street. Accommodation is provided for cables from both the old and new power houses, the latter being equipped with steam turbines. In laying the new ducts the old manholes had to be disturbed and working cables slung up until they could be disconnected and drawn into the new pipes.

A Suggestion!

OF all the causes assigned to the Bristol fire, that given by one of our lay contemporaries is the most amusing. It asserts that "the accident was caused by (as usual) the fusion of the wires of a new switch-board through over heating." Would it be temerity on our part to suggest that no fire was ever caused through such an event? Fires there have been in plenty produced through defective apparatus, and through arcs set up by fuses and leakage, but the collective wisdom of the Institution of Electrical Engineers, which authorised densities much higher than the old "safe" limit of 1,000 ampères per sq. in. of copper conductor, shows the opinion of the profession on such a suggestion as that quoted. The sting is of course in the "as usual." But we ask again, Is it usual?

Coal Deterioration.

STATION engineers are well aware of the deterioration of steam coal stacked in the open, and it is only dire necessity which causes them to adopt the practice at all. In the more modern designs provision is made for a ten days' or fortnights' storage under cover, but this is an initial estimate, and as the rate of use increases, the quantity it is found possible to maintain at hand drops to a few days' requirement in the winter period. It is by no means easy to ascertain the value of the coal before and after a period of stacking. Various figures have been given, but as the qualities of coal have not been precisely defined no general rule can be stated. Inspection of the bulk after a month's stacking shows the change which has taken place. It is not unusual for large lumps to have become so friable that they can be reduced to dust in the palm of the hand, and the greyish coating on the surface shows that a slow and gradual oxidation has been taking place. Some recent experiments by Mr. Myles Brown, with a highly bituminous coal of foreign origin, show that after a month of wet weather, with a varying temperature, the coal exposed to these climatic conditions had suffered little. The next period of about the same duration was dry and the temperature lower. During this interval the coal lost eight per cent. of its heating power. Another sample was exposed to the weather on all sides and lost about three-quarters of one per cent. in weight; another exposed only on one side lost only one third of this. It has generally been considered that the loss is a surface one, and is lessened by closely piling the coal, and some managers have found a coat of whitewash a protective against change. Others again adhere to the water storage principle, which is gaining favour in some directions.

ELECTRICAL · WORK and · PRACTICE in · the · Shops

The Artisan's Section.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike, which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

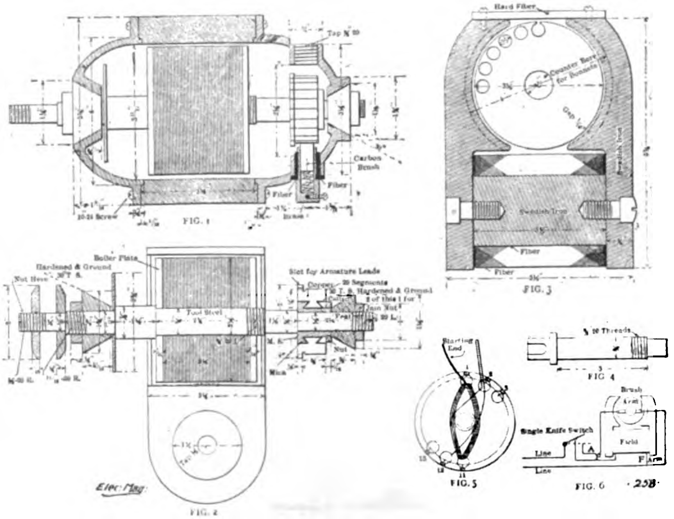
* * *

*A Handy Electric Grinder.**

THE general construction of this machine is simple, but the armature and winding will need some explanation. The armature proper is built up of thin charcoal iron or electrical steel. It will not pay to make a die for a single armature. Cut the stock into squares $3\frac{5}{8}$ × $3\frac{5}{8}$ in., punching a $\frac{3}{4}$ in. shaft hole in the centre. For armature heads use $\frac{3}{16}$ in. boiler plate, the heads being $3\frac{5}{8}$ in. dia., one drilled and the other tapped with a $\frac{3}{4}$ in. hole, the latter having 20 threads per in. Make a short mandrel like Fig. 4, and put on boiler plate head with drilled hole, then the discs and blanks, tighten up with the tapped boiler plate head and turn all down to $3\frac{1}{2}$ in. dia.

Next, lay out the $\frac{3}{8}$ in. holes for the winding slots by scribing a circle on each end, as it will be necessary to drill the holes from each end to bring them in perfect alignment. Finish by reaming, and, after reaming, mill $\frac{1}{8}$ in. slots or openings from the periphery into each hole, to pass the wire through when winding. After milling remove the discs from the mandrel, clean thoroughly with gasoline and paint them with shellac or armature varnish before assembling. After assembling on the shaft insulate each slot and the ends with hard fibre 1-64 thick, or, preferably, with flexible micanite.

When the armature is wound complete, each slot will contain 40 layers of No. 23 double-covered magnet wire. Cotton-covered will do, but silk-covered is preferable. Give the slots numbers from 1 to 20. Start in slot 1 and, leaving the starting end of the wire protruding about 4 in., wind to the slot diametrically opposite (or slot 11), winding alternately on each side of the shaft for balance, as in Fig. 5, until there are 20 layers—that is, 10 on each side of the shaft. Bring the wire up to slot 2, make a loop about 3 in. long and twist it for a commutator lead. Next wind from slot 2 to slot 12 twenty layers. Bring the wire to



ELECTRIC GRINDER.

---

* *American Machinist.*

slot 3 and make a commutator lead. Wind from slot 3 to slot 13 twenty layers. Repeat the operation from slot 4 to 14, 5 to 15, 6 to 16, 7 to 17, 8 to 18, 9 to 19, 10 to 20. This will give 20 layers in each slot with 10 commutator leads extending from one side, and the armature is one-half wound.

Continuing, wind from slot 11 to 1 twenty layers, and so on, till other half is wound, twisting the last wire to the starting end. This will give two distinct coils (or circuits) in each slot of 20 layers each and a double commutator lead from each slot. Do not cut the wire from start to finish. The leads are connected to the commutator on the quarter—that is, bend them around helically one-fourth turn and connect in rotation by soldering. The field coil is wound with No. 29 double-covered magnet wire. Make a spool of hard fibre to wind on and wind in the lathe, evenly to get as much wire in as possible. The ends of this coil should be soldered to a piece of lamp cord for leaders to connect up. After finishing the winding, put a layer of 1-16 cotton cord for protection. Shellac this. Fig. 6 is a diagram of connections for the finished machine to provide for starting it, and avoid a rheostat or starting box.

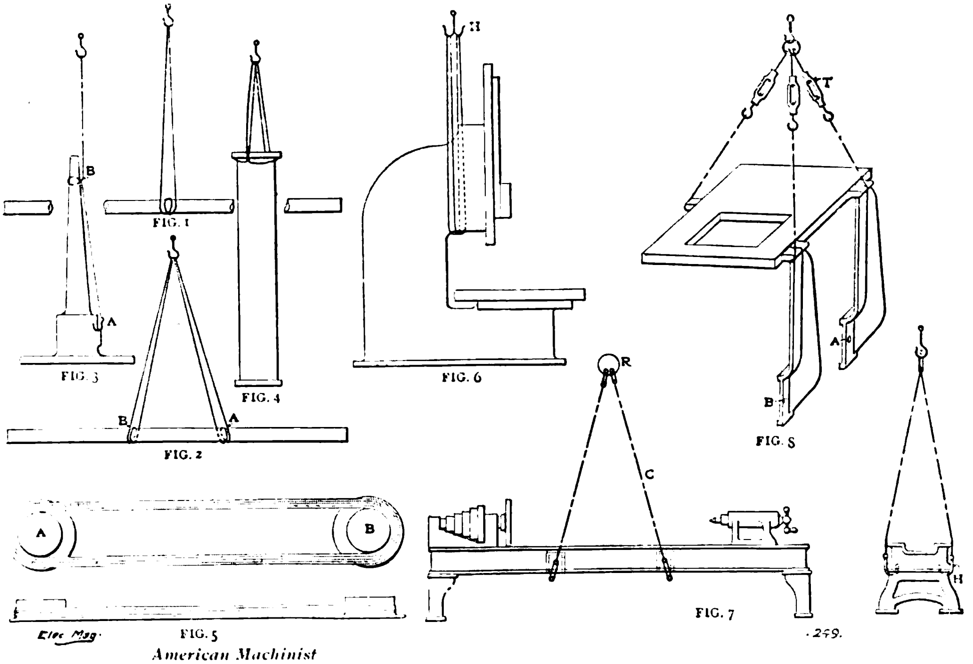
*SOME CRANE TIPS.**

THERE are many ways of handling things on the crane. It is not an uncommon thing to find the rigger in a shop applying a rope to a long bar of iron, as in Fig. 1. He guesses where the centre of gravity would come, and however closely he may guess, the bar will swing out of level when the crane hook is raised, and thus he is obliged to lower the crane hook, shift things one way or the other to suit and make another attempt. A satisfactory way of handling this work is shown in Fig. 2. An endless rope is taken and wrapped once around the bar, as shown; the two ends are then thrown over the crane hook. By pulling the rope apart at A and B to form a triangle, and by a guess at the centre of gravity and by placing the crane hook over it, we are able to lift this work at the first attempt.

In Fig. 3 is shown a column for a radial drill. It is difficult to rig up this column as in Fig. 1. A hook on the end of the chain is entered at cored hole, A; it is then carried nearly to the top of the column, given a turn, and from thence it leads to the crane hook. Fig. 4 shows a heavy cast-iron pipe, to be raised and lowered over a piston. This should be raised in a vertical position, in order to lower down over the work nicely. The safest way to handle it is to make a basket hitch, either with a chain or rope (Fig. 4). For handling extra heavy machinery proceed as shown in Fig. 5. A and B are two wheels with flanges. Around these tarred rope is wound, until sufficient is obtained to give the size and strength required. It is then bound together with tar rope, and covered with canvas. This is very useful for handling a finished machine, as shown in Fig. 6. The sling is put around the throat of the machine and the ends thrown over a double crane hook at H.

In Fig. 7 is a ring, R, to which four chains, C, are attached. These have special hooks at the lower ends, which engage in pockets underneath the bed. To keep these chains from abrading the finished faces, they are covered with leather.

In Fig. 8 is a motor bracket, with its supports, bolted up ready for the machine. It is difficult to level this up by ordinary means, and much time can be saved by having three turn-buckles fixed up in a chain, as shown. One other thing: trial holes can be drilled at A and B. The bracket is then held up, and the other holes A and B scribed on the machine.



American Machinist

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrcial trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

* * *

Canada, and Preferential Tariffs.

By the ASSOCIATE EDITOR.

It may be useful to note the figures relative to Canadian imports from the home country since preferential treatment came into effect in the year 1898. The value of the exports from the United Kingdom to Canada were approximately £8,140,000 in 1889, and dropped to £5,470,000 in 1897, but after the introduction of the preferential tariff, granting a rebate of 25 per cent. in the duty, the imports rose to £6,150,000 in 1898, and further advanced to £8,120,000 in 1900, when the rebate was increased to 33⅓ per cent. Apparently as a result of this further encouragement to British manufacturers the value of the exports increased to £10,700,000 in 1902, and continued improvement was evidenced during last year. These figures appear to be conclusive as to the practical advantages of preferential treatment. While referring to this subject we may mention that there is a strong feeling in the Dominion in favour of a protective tariff that will give adequate protection to every Canadian manufacturing industry. The opinion is openly expressed that the present tariff does not afford such protection to Canadian iron and steel and other industries, and that even loyalty to the mother country is not a sufficient reason for giving undue preference to Great Britain, or to restrict imports from foreign countries from which surplus requirements are obtained, and which Great Britain seems little disposed or unable to supply. Figures published in *The Canadian Manufacturer*, show that, in a selected list of two hundred classes of manufactured articles imported into Canada and in great demand there, Great Britain supplies only about 10 per cent., and the United States more than 83 per cent. of the total value. Articles of the kind included in this list can most probably be supplied on far more favourable terms by American than by British manufacturers, and it is by no means likely that Canadians would be prepared to pay higher rates simply for the sake of benefiting our own manufacturers.

THE FISCAL PROBLEM.

A CORRESPONDENT who is a Fellow of the Statistical Society writes congratulating us upon having opened our pages to discussion and controversy, and, availing himself of this facility, he desires to add to the figures mentioned in our recent article on the Fiscal Problem. He says that, according to the detailed trade returns of the United Kingdom, the average annual exports of electric lighting apparatus since 1890 to certain European countries were :—

Country.	Average per annum.
Germany	£6,578
France	£12,847
Belgium	£15,438
Holland	£8,449
Italy	£4,709

He does not give the figures for each year separately, but concedes that there are evidences of a loss of trade, thus endorsing our general argument as to the serious effect of hostile European tariffs upon British exports. On the other hand, he points out that there has been a gain of trade in non-European markets. For instance, he says, in 1892, out of a total export of £87,000 worth of electric lighting apparatus to foreign countries, nearly 50 per cent. was exported to non-European countries, and in 1902, out of a total export value of £195,000 for foreign countries, about 87 per cent. went to non-European coutries. Considering that the non-European countries include the United States and various South American Republics that are not free-trading states, our correspondent thinks this not a bad performance, when it is borne in mind how busy our manufacturers have been in supplying the home market. Perhaps some of our readers who are actually engaged in the manufacture of electric lighting apparatus will give us their views upon the development of export trade to such countries, as well as upon the far larger question already placed before them.

THE UNITED STATES EXPORTS.

From recent statistics we find that for the year 1903 the exports of goods manufactured in the United States amounted to $421,453,915, as against $410,650,967 for 1902, thus showing an increase of no less than $10,802,948, and it is noteworthy that the increase in December alone was more than one-half the total increase for the entire year. The following figures show the values of exports of some leading articles of American manufacture during the years 1902 and 1903 :—

Articles.	1902. Dollars.	1903. Dollars.
Automobiles and parts ..	1,069,782	1,643,029
Cars, carriages, etc. ..	7,500,064	8,506,092
Copper ingots and manufactures	45,485,598	43,509,788
India rubber manufactures	3,815,754	4,360,965
Electrical and scientific apparatus	6,466,201	8,145,923
Steel rails	1,902,396	937,779
Steel wire	5,140,702	5,528,726
Electrical machinery ..	5,937,643	5,104,502
Metal working machinery	2,863,709	3,316,088
Pumps and pumping machinery	2,516,300	2,729,288

In the foregoing we have only included such classes of manufactures as more particularly interest our readers. Although a decline is observable in "Electrical Machinery," it will be noticed that if "Electrical and Scientific Apparatus" be taken into account, an increase of over $845,000 is evidenced, while the exports of electrical machinery and electrical and scientific apparatus taken together amount to a very significant total, which should be compared with British exports of similar products.

HOME TRADE NOTES.

Exhibition Contract.

The contract for the electric light and power at the forthcoming South African Exhibition, to be held in Cape Town, has been obtained by the Torque Electrical Engineering Company, of 20-28 Dalling Road, Hammersmith, W. This firm has secured the contract against many competitors, and has, we understand, a large experience in connection with the fitting up of some of the most important electrical exhibits in this country.

New Generating Set for Newcastle.

A large three-cylinder triple-expansion engine has just been completed by Messrs. Victor Coates & Co., Ltd., of Belfast. This engine forms part of a new generating set for the Newcastle Corporation Tramways Station, and is direct coupled to a continuous current generator built by the British Westinghouse Electric Company. Although the normal output of the engine is 3,000 i.h.p., it is capable of developing 4,000 i.h.p. It will be of interest to know that this engine is of approximately double the power of any engine previously built by this firm, and it is said to be the largest triple three-cylinder engine built in the British Isles for elecrical work.

The Sturtevant and E.T.C. Amalgamation.

On January 1st, 1904, the business of the Electrical Transmission Company, of Hammersmith, was amalgamated with that of the Sturtevant Engineering Company, Ltd., of Queen Victoria Street, E.C., whose works are at Bankside, S.E. By this step, the extensive range of motor starting and controlling devices made by the Sturtevant Engineering Company, has been increased by the addition of the switch-gear specialities of the Electrical Transmission Company. The works at Bankside will in future be devoted to the manufacture of motor control apparatus, such as is used for lifts, winches, hoists, cranes, pumps, and of automatic controlling devices generally. The E.T.C. specialities, such as main switches, traction accessories, feeder and section pillars for power and lighting, service switches, motor starters, speed regulators, and kindred appliances, will be manufactured at the Hammersmith Works.

Westinghouse Works and the Fair Contracts Clause.

The British Westinghouse Electric Manufacturing Co., Ltd., of Trafford Park, have agreed to the insertion of the fair wages clause in future municipal contracts, to join the Employers' Federation, and to abide by the working terms mutually agreed upon by the Federation and the representatives of the trades unions. The concession which the Company has made is the final outcome of prolonged negotiations between the Company and the trades unions. When the works in Trafford Park were opened, the intention of the Company was to manage them precisely as their works were then managed in Pittsburg, but there soon arose a dispute on the question of overtime. In the United States, it is the custom to pay time and a half for all overtime, but the trades unions in England have another rule. The Company endeavourd to show that the American method was the more advantageous for all concerned, but the proposal that any exception should be made found no favour, and in the end the Company yielded the point, altered its system of book-keeping and paid for overtime as the unions asked to be paid. The unions are now satisfied and the Company really benefits, because under the new terms, only time and a quarter is paid for the first two hours, instead of time and a half, and the occasions when double time has to be paid are infrequent.

Coal Exports in 1903.

Steady progress in the export coal trade during 1903 is reflected in the figures for the year issued by the Board of Trade. Previous records as to volume were easily surpassed, 46,622,700 tons of coal, coke, and patent fuel having been shipped, as against 44,897,948 tons in the previous year. Exports of coal rose from 43,159,046 tons in 1902 to 44,950,057 tons in 1903; whilst 717,477 tons of coke were shipped, as compared with 688,646 tons in 1902; and 955,166 tons of patent fuel, as compared with 1,050,256 tons. In value, however, there has been a steady falling off. This is the most significant feature of the past year. Yet the prices of export coal have shown remarkable steadiness throughout the year, as will be seen by the following table:

Exports of Coal, Coke, and Patent Fuel.

	1903.		1902.	
	Quantity. Tons.	Aver. value.	Quantity. Tons.	Aver. value
First Quarter...	10,664,054	11 11·3	9,618 388	12 8·2
Second ,, ...	11,825,249	11 7·5	11,247,585	12 2·6
Third ,, ...	12,278,807	11 7·8	11,754,023	12 0·9
Fourth ,, ...	11,854,590	11 7	12,277,951	12 3 8
Twelve Months	46,22,700	161 7 9	44,897,948	12 3·4

NOTES ON FOREIGN TRADE.

Commercial Enterprise on the Continent.

Mr. J. Macaulay, the general manager of the Alexandra Docks and Railway, South Wales, recently made a tour of inspection in Belgium, Holland, and Germany, to ascertain how commercial enterprises are carried on in those countries. His impressions formed the subject of an article in the *Iron and Coal Trades Review*. Mr. Macaulay considers that the Germans are better able than we are to adapt themselves to meeting new commercial developments. Although acknowledging that Trades Unionism is good in many of its principles, he deplores the fact that the good worker is paid at the same rate as his less skilled brother. The author thinks that the foreigner is very quick to perceive changing conditions of trade, prompt to appreciate the practical value of scientific discoveries, and is generally aided by a thorough system of technical training.

St. Louis World's Fair.

Some of the principal features of this exhibition, as definitely arranged up to the present date, may be briefly summarised as follows:

1. The exhibit power plant in the Machinery Building, consisting of various prime movers connected to dynamos furnishing current for exhibition uses, and the boiler and gas plant in the adjoining Steam and Fuels Building.
2. The service power plant in the Machinery Building, with a nominal capacity of 8,000 K.W. in 25 cycle, 6,600 volt current.
3. The illumination of the grounds and buildings.
4. The cascade pumping plant, producing an artificial waterfall, with a discharge of some 90,000 gallons of water per minute, this plant incidentally serving the purpose of circulating the water in the lakes once every 4½ hours
5. Steam and electric railway exhibits, including locomotive testing plant and facilities for electric railway motor tests, both of which features will contribute substantially to the fund of engineering knowlege before the exhibition season closes.

State of Electrical Industry in Spain.

Electric lighting is used in Spain to a greater extent than all other European countries, by reason of the prohibitory cost of gas lighting there. A graphical record is given in the *Elektrot-Zeitchr.* of the development of electric central stations since 1878, when the first plant was put into operation; the present figure appears to be 100,000 K.W., corresponding with about 5 watts per inhabitant, whereas the number of central stations worked in Spain at present is about 1,000. The electricity works at Madrid comprise a total output of 16,600 K.W. and 70,700 K.W. of secondary batteries, corresponding with 66 installed watts per inhabitant, as compared with 48 watts per inhabitant in Berlin. As of late years immense quantities of water power have been utilized, electric light has found its way now even to the house of the poorest man. These hydraulic central stations are mostly alternating current plants, serving in most cases to supply localities with electric energy. They are devoid of any complicated switching and regulating apparatus, so as to be superintended by unskilled persons, the light being mostly paid for in a lump sum at so much per day per lamp. Wherever some control of the consumption is desirable, as for instance in smaller cities, so called "current limiters" are installed, automatically interrupting the current at a certain fixed number of lamps simultaneously burning. The financial result of these works are excellent, dividends as high as 30 and 35 per cent. being frequently paid.

The Development of Chili.

A Great British Enterprise.

It is most gratifying to know that a British corporation has undertaken, on a very extensive scale, the industrial development of Chili, a country affording exceptional scope for such an enterprise, and presenting an ideal field for the operations of the electrician in the future. Excellent opportunities exist for the electrification of railways already built, and for the making of new electrical lines. The corporation to which we refer is the Chilian Exploration and Development Syndicate, whose operations will be divided into four departments:—Engineering, mining, trading, and financial. The engineering department will deal with all classes of engineering, electrical, architectural, and industrial businesses; it will prepare plans, specifications, estimates, and details necessary for public and private works, such as the construction of railways, graving and other docks, the construction of floating docks and pontoons, canals, etc., and, in the towns of Chili where such work may be required, the construction of tramways, public buildings, electrical works, drainage and sewage undertakings. The mining department will obtain and deal with options on gold, silver, copper, coal, and manganese, nitrate and other mineral properties, for the purpose of exploiting, developing or otherwise dealing with the same, and of introducing the best up-to-date methods and machinery relating to the mining industry, which is at present comparatively undeveloped in Chili. The trading department will deal with the imports and exports of the country. It is proposed that an exhibition of British manufactured goods shall be opened in Santiago, a city to which buyers are attracted from all parts of the country. The trading department will also deal with shipping business and navigation. The financial department will undertake financial business connected with the industrial development of the country, and at the same time will finance the other three departments and act as accountants for the syndicate.

TENDERS INVITED.

Tenders are required for the electric lighting of the town of Punta Arenas (Straits of Magellan). Tenders by June 28th. All particulars can be obtained at the Chilian Legation, 29 Queen's Gate Terrace, S.W.

The Technical School of Bilbao invites tenders for a number of dynamos and motors, a gas engine, and accumulator battery. Tenders by April 12th. Particulars to be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao.

SOME CONTRACTS OF THE MONTH.

Power.

London County Council: Four 3,000 K.W. three-phase generators, £29,600; Electric Construction Co. Boiler feed pumps, £3,618 (Greenwich); John Cochrane & Co. Fuel economiser, £3,071 6s. (Greenwich); E. Green & Son. Low tension switchboard; Bertram Thomas

Battersea Borough Council Lighting Committee: Coal handling and conveying plant, £2,337; Graham, Morton & Co.

Battersea Borough Council: Steam turbine dynamo, £4,890; C. A. Parsons & Co.

Croydon Electricity Works: Extension to works, £2,905; Dorman, Long & Co. Chimney shaft, £3,823; Alphons Custodis Chimney Construction Co.

Kingston Town Council: 200 K.W. generator, £2,112; Siemens Bros. & Co.

Radcliffe District Council: Lighting and traction switchboard, £1,345; J. G. Statter & Co.

Cardiff Electrical Committee: Engine and generator, 500 h.p., £3,390; Siemens Bros. & Co.

Todmorden Town Council: Steel boilers; Yates & Thom. Economiser; E. Green & Son. Storage battery: Electric Power Storage Co., Ltd. Condenser pumps and injectors; Worthington Pumping Co. Switchboard; B. Thomas. Cable work; W. T. Glover & Co. Steam dynamo and engine; Bruce, Peebles & Co. Crane; Rodgers & Hay

Glasgow Town Council: Six motor generators, £9,958; Electrical Co., Ltd.

National Provincial Electric Corporation: Complete equipment of generating station at Bridgwater, £13,000; Sir Hiram Maxim Electrical & Engineering Co.

Fife Electric Power Co.: Generating plant, engines, boilers, etc., £23,590 (Dunfermline Station); Bruce, Peebles & Co.

Enniscorthy Asylum: Generator, etc, £599; Thos. Parker. Ltd. Motor and motor pumps, £347; British Westinghouse Co. Accumulators, £243; Pfluger Accumulator Works. Switchboards, £156; wiring, etc, £753; Porte & Co. Overhead wires and steel poles, £636; British Insulated & Helsby Cables Co. (Total, £2,734.)

New South Wales Rly. Commissioners: Extensions for power house, Ultimo, £48,000; James Howden & Co.

Cape Town Industrial Exhibition Authorities: Electric lighting and power: Torque Electrical Engineering Co.

Johannesburg—Messrs. Harvey, Greenacre & Co.: Complete current generating plant; A. W. Penrose & Co.

Allan SS. Co.: Four 60 K.W. generators for two turbine steamers; British Electric Plant Co

Traction and Transport.

Bradford Corporation Tramways & Electricity Committees: Steel tramway poles, £662; J. Russell & Sons Steel girder rails, £3,987; steel fishplates, £269; Bolckow, Vaughan & Co. 1,000 K.W. generator, £3,272; British Westinghouse Co. Steam engine, £7,870; J. Musgrave & Co.

Rowley U.D.C.: Tramways; Birmingham & Midland Tramways Co. Electrical equipment (recommended).

London County Council: Railway turntables, £805; Ransomes & Rapier, Ltd.

Walthamstow U.D.C.: Permanent way, overhead equipment, underground cables; W. T. Henley's Telegraph Works Co., Ltd.

Underground Electric Railway Co: Signalling equipment; Westinghouse Brake Co Motors for trains; British Thomson-Houston Co. Electric lifts, £350,000; Otis Elevator Co., Ltd. Stamped steel troughing; Sir Hiram Maxim Electrical & Engineering Co

Brighton Town Council: Steel poles, £969; Stewarts & Lloyds, Ltd. Trolley wire, £325; F. Smith & Co. Bases and section pillars, £313; Rowland Carr & Co. Cast-iron fittings, £42; J. Needham & Sons. Pole brackets, £173; Dick, Kerr & Co. Overhead line fittings, £97; W. Wood & Co. Span and guard wire, £15; F. Smith & Co. Switchgear, £38; W. Wood & Co. Feeder distributing and telephone cables, £3,209; British Insulated & Helsby Cables, Ltd. Bonds, £580; R. W. Blackwell & Co Wood paving blocks, £7,100; Acme Wood Flooring Co. Granite setts, £615; Brooks, Ltd.

Southend Town Council: Extensions to car-shed at tramway depôt, £2,647; J. C. Flexman.

Kirkcaldy Corporation: Seven motor cars for tramways, £4,125 13s; British Thomson-Houston Co.

Aberdeen Suburban Tramways Co: Equipment of lines; J. G. White & Co.

Sydney: Cables for tramways; W.T.Henley's Telegraph Co.

Preston Tramways Committee: Steam and feed piping, £891; Dick, Kerr & Co.

Temiskaming & Northern Ontario Railway Commission: 6,000 tons 80lb. steel rails; Charles Cammell & Co., Ltd.

Walsall Corporation: 100 tons tram rails; Leeds Steel Co.

Newcastle Tramways Committee: 2,000 tons of steel rails and fittings, £10,475; Bolckow, Vaughan & Co.

Lighting and Heating.

Walsall Town Hall: Wiring and fittings, £974 1s.; Arundale & Rowbottom.

Royal Victoria Hospital, Netley: Storage battery, 115 cells; Hart Accumulator Co.

Swindon Municipal Corporation: Reason arc lamps; L. Howell. Arc lamp carbons; Steel Bros

May Oatway Fire Appliances, Ltd.: Wiring Govan Ropeworks; Carrick & Topping. Wiring Messrs. J. Templeton & Co.'s premises; Wylie & Lockhead, Ltd.

Whitby U.D.C.: Feeder and distributing mains, £1,396; Callender's Cable & Construction Co., Ltd.

Windsor Town Council: Public lighting, five years; Electric Installation Co.

Harrismith: Electric lighting plant; Mather & Platt.

HOME TRADE NOTES.

The following orders have been received by the various firms enumerated below :—

MESSRS. MATHER & PLATT, electric lighting plant at £5,617, for Harrismith, and two electrically driven high-lift centrifugal pumps for De Beers Consolidated Mines, Ltd., South Africa.

MESSRS. BROWETT, LINDLEY & CO., LTD. :—A 430 K.W. engine and dynamo at £4,619, for Kirkcaldy; a 250 K.W. steam dynamo with condensing plant and pipe work, for the U.D.C. of Long Eaton; and a 150 K.W. steam engine for use with highly superheated steam for the U.D.C. of Bexley.

MESSRS. BABCOCK & WILLCOX :—For supplying and fixing three superheaters at Hampstead, £3,879; boilers for the Brighton Corporation Power Station, at £28,140; and two water-tube boilers, over-head flue, coal bunkers, coal handling plant, and extensions to steam and exhaust pipes at Bermondsey, £7,990.

THE BRUSH ELECTRICAL ENGINEERING CO. :—Ipswich Corporation (per British Westinghouse Co), 10 car bodies and trucks; Manchester Corporation, 100 car bodies and 10 pairs bogie trucks for electric tramcars; Sunderland District Tramways Co. (per Bruce, Peebles & Co.), 30 car bodies and trucks; Gloucester Corporation, 10 car bodies and trucks; Aberdeen Suburban Tramways (per Messrs. F. G. White & Co) 6 double-deck cars with single trucks; and Gravesend and Northfleet Tramways Co., two "one-man control" cars, complete with trucks and electrical equipment.

MESSRS. BELLISS & MORCOM :—From Messrs. Siemens Bros. & Co., Ltd., a 300 h.p. engine to be coupled to a Siemens alternator for Kingston-on-Thames; two 290 h.p. engines to be coupled to Siemens 250 K.W. generators for Pembroke Dockyard; The English Process Co., Ltd, Birkenhead, two engines for coupling to Siemens dynamos; one engine for coupling to a Brush dynamo for Tasmania (per the Brush Co.); for Kilmarnock (per Dick, Kerr & Co.), four engines for coupling to English Electric Co., Ltd., dynamos; and (per the British Westinghouse Co.), one 580 h.p. engine for coupling to 400 K.W. Westinghouse generator for Chesterfield.

THE BRITISH WESTINGHOUSE CO :—A motor generating set from the Ashington Coal Co, and for a 5,000-volt alternator from Messrs Noyes Bros., Dunedin; one engine and dynamo, comprising a Browett-Lindley 120 size three crank, three-cylinder, triple-expansion engine, driving a 450 K.W. Westinghouse dynamo for the Blackpool Corporation; one 400 K.W. engine dynamo, together with switchboard and auxiliary apparatus, a Babcock & Wilcox boiler, and a Worthington jet condenser for the Chesterfield Corporation; two gas engines and auxiliaries for the Corporation of Tiverton (per Messrs. F. Suter & Co.)

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

London Electric Railway Returns.

By the ASSOCIATE EDITOR.

During the month of February meetings were held of the shareholders in the different tube railways in London to consider the reports for the half year ending December 31st, 1903. The most noteworthy feature in the returns then presented to the public is the decrease in receipts as compared with the figures for the corresponding half year of 1902, and at each meeting the chairman dealt with this matter at some length. In some quarters there seems to have been a tendency to attach too much importance to this point, and, in the case of the City & South London Railway, to attribute it to the competition of the County Council electric tramways. But to us there appears to be no cause for alarm. No year could be worse as a standard for comparison than 1902, as the traffic in that year—first in June, and again in July and August—was quite abnormal, owing to the Coronation festivities. In such a state of affairs it is not at all surprising that the Central London Railway, for example, should have carried 351,122 persons more in 1902 than in 1903, and it would be foolish to deduce from this fact a conclusion adverse to the prospects of that railway, especially when, by going back to 1901, we find that the number of persons carried in that year is less than that for 1903 by 3,765,599. We must further note the fact that trade in recent months has been dull, and shopkeepers everywhere have complained of the absence of customers; and as London "shoppers"—as distinct from those who regularly use the railways every morning and night in going to and coming from their business—add materially to the passenger returns on these lines, their absence must have a corresponding effect.

TUBE v. TRAMWAY.

With regard to the alleged effect of the competition of the County Council tramways with the City & South London Railway, we think it is too soon yet to make a true estimate of this effect, and, indeed, we doubt if it will, in the end, be found to be serious. It is common knowledge that there have been serious complaints in South London at the delays on the tramway lines in travelling from the outer areas to Westminster or Blackfriars, and even when the horse cars are no longer "spatch-cocked" in between electric cars, such delays will probably continue, though they should not be so marked. No one to whom time is of any moment will take a car, stopping repeatedly and liable to be blocked by other traffic, in preference to a train which goes speedily and without delay to its destination. For short stages—point to point traffic—the car may have the advantage from its easy accessibility and from the halfpenny fares in vogue; but beyond this we do not expect to see the tramway supplant the tube railway in popular favour. There is room for both, and they will obtain an increase in their passenger returns, not by stealing from one another, but by together creating an addition to the numbers of the travelling public.

THE METROPOLITAN RAILWAY.

An interesting example of the effect of new facilities for locomotion upon the numbers of the travelling public may be found in some figures given by Colonel Mellor when presiding at the recent meeting of the Metropolitan Railway Company. He pointed out that the largest business ever done by the Company was in 1899, when 96 million passengers were carried. In the following year the Central London Railway was opened; the traffic on the Metropolitan at once began to fall, and in 1901 the total number of passengers dropped to less than 88 millions—the lowest figure reached in recent years. The Company has since then made strenuous efforts, by lowering fares and otherwise, to recover this lost traffic, and in the year 1903 they have raised the total to over 94 millions. That is, of the eight million which were lost in 1901, when the Tube competition became severe, six millions have now been recovered, and yet the returns on the Tube for 1903 also show a good increase over those for 1901. Thus new railways and improvements on old railways create new traffic, and this fact makes still more complicated the locomotion problem in London.

MAIN LINE RAILWAYS AND ELECTRIC TRAMWAYS.

THE competition of electric tramways is a much more serious matter for the main line railways than it is ever likely to be for tube railways in London, and at the statutory meetings of the main line companies, frequent reference is made to this subject. It is in the suburban districts that this competition is most keenly felt, and when we consider the nature of the service on the steam suburban lines—slow trains and in many cases an irregular and infrequent service—it is not difficult to understand why the newer form of locomotion should be more attractive. We notice that the chairman of of the London & South Western Railway Company puts the loss of that company during the past year from increased competition with tramways in the suburbs of London and in several provincial towns at no less than £10,000. In the case of the North-Eastern Railway, although no precise figure is given for the loss from this cause, we are told that the company "had suffered severely from competition in certain districts with the tramways," and that in the Newcastle suburban district the decrease in passenger traffic on the company's lines was no less than 61 per cent. This is a serious state of affairs, and the question, therefore, is whether there is a remedy for the "evil," or must it be accepted as permanent?

Are they necessarily rivals?

BEFORE answering the question in the last paragraph, it is right to point out that electric tramways are not always rivals of main line railways, but may, in fact, help them considerably by serving as feeders. Some of the companies have recognised this fact, and one at least has itself promoted tramway schemes in the provinces with this object. We believe that much may be done by a policy of this kind to improve the financial position of the companies, and in considering now the question of tramway competition, we do not forget, but rather emphasise, this other aspect of the question.

A Remedy for Competition.

RECOGNISING, however, as we must, that in many cases there is serious competition, we must look for a remedy. This, in our view, is only to be found in the electrification of those lines with which the tramway competition is most severe, and we are glad to notice that this is being recognised by some of the railway companies. The directors of the North-Eastern Railway Company, for example, appear to be alive to the situation. Their chairman has stated that the problem would have to be faced, and while taking the very philosophic and wise view that "they could not expect always as railways to have a monopoly of carrying," he expressed the belief and hope of the directors that by electrifying some of their suburban lines they would to a certoin extent solve the problem. We sincerely hope that an effort will soon be made on the suburuan lines of this and other companies to introduce the newer form of locomotion which will enable them to cope more successfully with their traffic, and will more than restore what has been lost. There are, of course, serious difficulties in the way, and these cannot be lightly swept aside; but with an earnest attempt on the part of the authorities, we see no reason why they should not be overcome.

FINANCIAL NOTES.

Motor Cars on Railways.

IN dealing with this question of the improvement of the main line railways, reference is necessary to the experiments now being made with motor cars. The Great Western Company started experiments a year ago, and in October last they began running self-propelled cars between Chalford and Stonehouse, with the very satisfactory result that a large local traffic has been developed in that district. Similar cars are therefore now to be introduced on other parts of the company's system. Then the North-Eastern Company has adopted a similar policy, and hopes to improve its branch line service by relying largely upon a system of single-coach auto-cars; and finally the chairman of the Great Eastern Company has announced that they are about to try between Ipswich and Felixtowe a train something on the model of that now running on the Great Western, at Stroud. These are all steps of progress, and every one will watch with interest the result of the trials.

Rating of Railways and Tramways.

Is it impossible to find a more equitable method of assessment of railways for purposes of rating? Year after year we find the main line companies complaining bitterly of the severe drain upon their revenue in the form of local rates and taxes, and no one can deny that the complaint has much justification. It would be bad enough if this taxation were all rendered necessary for the conduct of proper municipal business, but when it is partly used to support municipal tramways which are run in direct opposition to these railways, the position becomes absolutely unjust. Local rates are steadily rising, and the railway companies, who have no say in the fixing of these rates, are the heaviest sufferers. The system of rating is largely at fault, as, althought it has now been long established and has proved workable, it is not based on very rational principles and leads to inequitable results. The question of the rating of tramways, where the same method is followed, has recently been discussed by Mr. Bond before the Tramways and Light Railways Association, and we hope that the attention of Parliament may soon be called to the problem, and some scheme devised to place railways and tramways on a fairer footing in this matter.

Sinking Funds in Electrical Undertakings.

We have received a copy of an interesting pamphlet on "Redemption of Electricity Loans," by Mr. Beckett, accountant to the Borough of Accrington. The writer refers to the "Electric Supply Costs and Records," published by our contemporary, *The Electrical Times*, and, noting the figures given there in the columns headed "Amount provided for Sinking Fund," and "Sinking Fund per cent. to Capital," he calls attention to "the prodigious variety of centesimal rates for assets of an equally wasting nature." He has himself inquired into the period for which the loans in the different town are granted, and in an appendix he gives for each town, *inter alia*, (1) the equated period for repayment of capital authorised; (2)—calculated from (1)—the centesimal cost of the sinking fund to the whole of the capital authorised; and (3) the centesimal cost of sinking fund to capital outlay (as per *Electrical Times*) A comparison of the values under (2) and (3) is instructive and of great interest. We commend the author's remarks to municipal authorities, to whom this subject of repayment of loans is of the greatest importance.

Municipal Blackmail.

During the past month the different private Bills deposited in Parliament have been examined by the proper officials to see if the Standing Orders have been complied with, and as a result of this examination many bills are to-day much less imposing than they were a month ago. With tramway bills the non-compliance with Standing Orders is almost invariably due to failure to obtain the necessary consents of local authorities, and the frequency with which this occurs would in itself be sufficient to raise a suspicion that these bodies are withholding their consent improperly, and without regard to the convenience of the public. But when the matter is investigated further, suspicion becomes certainty, and we find that this veto is being freely used for what is practically blackmailing; and local authorities are seeking to screw out of tramway companies, as the price of their consent, enormous sums of money to be spent on matters which may have no connection whatever with tramways. In many cases companies have been already fleeced in this manner before they could obtain permission for their lines; but with local authorities desire seems to grow with that which it feeds on, and each year their demands become more outrageous and exorbitant. Naturally, there can only be one result. The companies must, and do, refuse to purchase consents on such terms, preferring rather to drop their tramway promotions, and so the municipal councils get nothing at all.

The South African A.E.G.

We are now able to give some further details of this company and its programme. Mr. De Norwald has taken up in London the position of managing director, and has favoured us with the particulars. In undertaking electrical work, the engineering portion will be handed over to English manufacturers, and the electrical section to A.E.G. shops in Berlin. The company claims international support, and, we understand, has drawn much of its capital from other than purely German sources, consequently its objects can be said to centre in the general electrical development of South Africa. The company is affiliated with the A.E.G., Berlin.

No Fog, but Good Dividends.

"It's an ill wind that blows nobody good," and while ordinary people cordially detest fog and rejoice at its absence from London this winter, the electric supply companies find in this fact a cause of regret, and look upon the fog as their best friend. Still, even without fog, these companies are able to show good balance sheets, and the dividends announced are a witness to good management and successful enterprise. The following are some of the ordinary dividends for 1903:—

St. James' and Pall Mall Electric Light Co. ..	14½	per cent.
Westminster Electric Supply Corporation ..	13½	,,
Kensington and Knightsbridge Electric Lighting Co.	12	,,
Brompton and Kensington Electric Supply Co. ..	10	,,

The Case of the London United Tramways.

As an example of this blackmailing process, nothing better could be found than the action of Brentford with regard to the Bill promoted by the London United Tramways Company. That Bill sought powers for a very extensive system of tramways in various districts, but Brentford was only concerned with one small piece of line, one end of the proposed line across Kew Bridge. No other part of the proposed lines fell within the area of the Brentford Urban District Council, yet, as the price of the consent for these few yards of track, this Council demanded that the company should carry out various extensive "improvements" in the town, costing about half-a-million sterling! A subway, an underground lavatory, and a widened thoroughfare through the centre of the town—these are some of the spoils which Brentford hoped to exact from the company. Well might the chairman at the recent company meeting say to the shareholders, "We began to think, as directors of the Company, that we were a little unfortunate in having a tramway undertaking in the neighbourhood of Hounslow Heath." We do not suppose the members of Brentford Council will like the suggestion that they, as a Council, have inherited the predatory instincts of the gentlemen who in bygone days lived in their neighbourhood and took what they could get *vi et armis* from wayfarers on the Heath; but until they conceive a clearer notion of the distinction between a fair bargain and improper extortion, we venture to think the public will approve of the allusion.

Oppressive Standing Orders.

YET we cannot lay the whole blame for the present state of affairs on the local authorities. Parliament must share the responsibility, as it has put it in the power of these bodies to behave as they have done. However justifiable it may have been originally to draft the Standing Orders in their present form, Parliament ought, as guardians of the public welfare, to have amended its rules when it became evident that they were capable of being abused in this manner. This particular Standing Order was originally intended to protect the interests of the public in local communities, but it is now used frequently in opposition to their real interests, and as a means of relieving the local councils of their proper functions. It is absolutely necessary that this veto should be withdrawn, not only because it stifles sound and honest enterprise, but also because it tends to municipal corruption, and is in every sense a great evil. This, no doubt, has often been said before, but it must be repeated again and again until such exactions as those made by Brentford are rendered impossible.

Tramway Parcel Delivery.

As tramway managers are naturally always looking out for new sources of revenue, we would draw their attention to the report of the Dublin United Tramways Company, issued in February. We have always felt that much could be done by tramway companies as parcel carriers, and we therefore are glad to note the success which has attended the enterprise of the Dublin company in this direction. In the report of the chairman's speech to the shareholders, the following passage occurs: "The receipts from parcel delivery, which has proved such a great convenience to the citizens, continued to increase, and they reached in the last six months the substantial sum of £2,873." There must be many systems in Great Britain where enterprise of this kind would be advantageous to the community and profitable to the undertakers, and we hope to see the example of Dublin followed elsewhere. Of course where a tramway system is in the hands of a municipality, there are difficulties in the way, if delivery is to be made at any point in the town, and not only along the route, and serious objections might be urged against this proposal. Parliament might therefore refuse to give the necessary powers, but there is no reason why private tramway companies should not receive the necessary authorisation. With parcel delivery along tramway routes only, all undertakers alike might be entrusted.

Motors on Hire or Hire-Purchase Systems.

"SHOULD electric supply undertakings advance motors on hire or hire purchase systems?" This is the title of a paper read at a recent meeting of the Glasgow section of the Institution of Electrical Engineers, but we regret to find that the author does not answer his own question. Everyone knows already what the author points out, that under a hire or hire-purchase system, customers may be obtained who cannot afford to buy a motor outright, and that thereby an increase on the day-load may be made; but as this same result may be obtained if manufacturers sell motors on the hire-purchase system, it does not follow at once from the author's argument that it is wise for the undertakers to act as middlemen between the manufacturers and the public. But the real difficulty occurs where the undertakers are municipal corporations, and there are very serious objections to the proposal in this case which do not apply against a company. Yet the author says he cannot see why objections should be made, and seeks to clinch his contention by the statement that "we do not hear objections raised when the supply is controlled by private enterprise with private money, or private enterprise with corporation money." This, of course, begs the whole question, and the author's further remark that the great majority of objectors are interested in the sale of inferior or foreign motors, is absolutely ridiculous, and shows that he has not grasped even the elementary principles underlying the subject of municipal trading. The paper is most disappointing.

BREVITIES.

Strong Opposition.—There is an imposing list of petitions against these four bills, and undoubtedly the promoters will have to fight hard for success. In the case of the Lincolnshire and Yorkshire, and East London and Lower Thames Bills, the contests promise to be exceedingly interesting.

London Electric Lighting.—A Government Bill has been introduced in Parliament to re-adjust the areas within which electric lighting companies and municipal authorities are authorised to supply electricity in London, so as to make them accord with the changed boundaries under the London Government Act, 1899.

MUNICIPAL ELECTRIC LIGHTING EXTENSIONS.

Middlesborough and Belfast.—Middlesborough Corporation is applying to borrow £20,000, and Belfast Corporation to borrow £4,350, for electric lighting extensions.

Plymouth.—Plymouth also wants £20,000 for additional plant for its installation.

Frome.—The Local Government Board has sanctioned the borrowing by Frome Urban District Council of £8,500 for electric lighting extensions.

TRANSFERS OF PROVISIONAL ORDERS.

Gorton.—Gorton District Council has held a Lighting Order since 1899, but has done nothing with it, so the Board of Trade recently declared that after June 30, if nothing were then done, the question of revocation of the Order would be considered. Under this pressure, the Electricity Committee has decided to hand over the Order to Manchester under a lease.

Widnes.—Widnes Town Council proposes a transfer of its Order to a Company. It is going to Parliament for an extension of its Lighting Order of 1901 with special provision for transfer, and it has decided to hand over the right to generate the electricity for the supply of the town to the Mersey Electric Supply Company.

Halesowen.—Another instance of a transfer of a local authority's Provisional Order to a company occurs at Halesowen, where an agreement has been made by which the Empire Electric Light Company takes over from the District Council its electric lighting and light railway orders.

Devizes.—At Devizes, again, the same question has been discussed, and notice has been given in the Council to rescind the motion by which the Council formerly decided to use the powers under their electric lighting order themselves.

Worth Noting!—Thus the change of policy among the smaller local authorities with regard to electricity supply, to which we called attention in an earlier issue, is gradually becoming more general, and we believe that much good will result from it.

It is also worth noting that "The Electrical Magazine" is best secured by annual subscription. Unique advantages are obtained.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A., 78 Fleet Street, E.C.

Means for Operating Mercury Vapour Electric Lamps.

Ezechiel Weintraub, Schenectady, U.S.A. No. 28417. Date of application in United Kingdom, 28th Dec., 1903. (Date of 26th Dec., 1902, claimed under International Convention).

This invention relates to the operation of electric lamps in which the current flows through the medium of a vapour such for example as the vapour of mercury, and comprises certain improvements whereby a plurality of lamps of this character may be operated in series with each other, either in a constant current circuit, or from a source of current of constant potential. In carrying out the invention means are provided, whereby all of the lamps may be connected in circuit and whereby the lamps may start independently of each other.

Claims.—(1) The combination of a plurality of vapour electric lamps, and means for starting and running said lamps in series with each other.

(2) A plurality of vapour lamps adapted to be connected in series with each other, in combination with a starting device connected in shunt to the main terminal of each lamp and means for simultaneously energising the starting devices.

(3) The combination of a plurality of vapour electric lamps, connections inter-linking said lamps in series with each other, means for impressing upon the lamp circuit an electro-motive force of a value sufficient to maintain the lamps in normal operation, and means for starting said lamps.

(4) The combination of a plurality of vapour electric lamps, each provided with a pair of terminals, connections between said terminals interlinking all of said lamps in series with each other, means for impressing upon the lamp circuit an electro-motive force of a value sufficient to maintain the lamps in normal operation, and means for starting said lamps into operation.

(5) The combination of a plurality of vapour electric lamps, each provided with a pair of terminals, connections between said terminals interlinking all of said lamps in series with each other, means for impressing upon the circuit an electro-motive force of a value sufficient to maintain the lamps in normal operation, and means for permitting any one of the lamps to start independently of the others.

Field Magnets for Alternating Current Motors.

Giorgio Finzi and Emil Korrodi, both of Milan, Italy. No. 17,185. Dated 7th Aug., 1903.

This invention relates to field magnets for alternating current motors, which presents the conditions for an efficient commutation of the current and at the same time permits of attaining a high value for the power factor.

Briefly stated the conditions for efficient commutation are as follows :—

The factors which influence the variation of the current in the short-circuited coils and the current density under the brushes, are :

(a) The contact resistance at the brushes.

(b) The resistance Rs of the short-circuited coils.

(c) The resistance Rv of the connections between winding and collector.

(d) The inductance of the short-circuited windings which generate the E.M.F. Es of the self-induction.

(e) The E.M.F. ee generated in the windings through the leakage field.

In alternating current motors the E.M.F. produced in the short-circuited windings through the periodic variations of the field strength must also be considered.

With continuous current good results are attained both theoretically and in practice when the inducing field presents such a form that it produces in the short-circuited windings an E.M.F. e_1 which at that moment corresponds to the following formula :

$$e_1 = Es + Ia\ (R_s + 2R_v)$$

The thickness of the brushes does not exceed that of a segment of the commutator, together with insulation when Ia is the current in the armature.

Claim.—Magnetic frame or field magnet for alternating current motors with collector, characterised by the fact that the pole surface opposite to the armature is decreased in cross section by tapering towards the armature in order to obtain efficient commutation and a high power factor.

An Apparatus for Determining the Length of Waves and Observing the Oscillations in Electric Oscillation Systems.

Adolf Franke, Gross Lichterfelde, near Berlin. No. 18,181. Dated 22nd Aug., 1903.

This invention has for its object an apparatus for the direct measurement of the wave lengths of electric oscillations as well as the examination of the oscillations in electric oscillating systems. The apparatus for this object has a closed oscillation circuit which is coupled with the system to be examined in the ordinary manner, electro-magnetically, electro statically, or in any other way, so that it swings with the system to be examined.

Claims.—(1) An apparatus for determining the length of the waves and observing the oscillations in electric oscillation systems utilising a closed oscillation circuit to be coupled with the system examined, with variable electric values, characterised by the capacity or the self induction of the oscillation circuit, or both these values undergoing a gradual alteration within wide compass, whilst the adjusting device employed therefor is connected with a reading off device indicating the length of the waves corresponding to the actual adjustment, and by the oscillation circuit itself being directly or inductively connected with a current meter (heating-wire instrument) so that by the simultaneous use of a current meter for the strength of current of the oscillations and an indicating device for the length of waves, an exact determination of the latter and judgment of the working of the oscillation system to be examined, and more particularly the sharpness of the wave formations is rendered possible.

(2) A form of construction of the apparatus described in Claim 1 characterised by a considerable enlargement of the measuring capacity beyond the limits afforded by the alteration of one of the electric values (capacity) being attained by altering the other electric value (self-induction) in definite stages which are so calculated that the gradual alteration of the one value for the progressive or continued enlargement of the measuring capacity may be utilised within the limits enlarged by the added amounts of said alteration.

(3) The improved apparatus for determining the length of the waves and observing the oscillations in electric oscillation systems, comprising the several parts constructed and designed to co-act.

Improvements in, and Means for, Effecting the Regulation of Asynchronous Alternating, or Three-phase, Current Electric Motors and Rotary Converters.

James Yate Johnson, London (communicated by the Elektrizitäts-Aktien-Gesellschaft, vormals W. Lahmeyer & Co., of Frankfort-on-the-Maine). No. 26,378. Dated 2nd Dec., 1903.

This invention relates to the regulation of asynchronous alternating, or three-phase, current electric motors, which, in consequence of their being subjected to irregular loads, are provided with energy-storing masses, or fly wheels.

According to the invention, mechanical auxiliary means for regulating the number of revolutions of alternating, or three-phase, current motors, are done away with by controlling the resulting field, and consequently the slip thereof, by means of a regulatable choking coil switched into the secondary armature. In other words, the said field is varied by means of a self-induction coil, the self-induction of which is controlled by varying the current passing through it.

Claims.—(1) For regulating asychronous alternating, and three-phase, current motors connected to energy storing masses, in which motors the resulting magnetic field and slip have to be varied, a variable self-induction, or choking, coil, included in the secondary circuit of the said motor and regulated by a direct current excitation regulated by the number of revolutions or load at any given time.

(2) A modification of the regulation which consists in varying, by means of a centrifugal governor, the excitation of the continuous current winding on the choking coil.

(3) A modification of the regulation in which the energizing force of the continuous current winding on the choking coil is regulated automatically by causing the magnetic circuit of the choking coil to be excited by two continuous current windings working in opposition, whereby the differential action of both windings produces, when one of the continuous currents in increased, an increase of the self-induction and *vice versa*.

(4) A modification of the regulation in which the choking coil is included in the secondary circuit of the motor and its self-induction varied directly, or indirectly, by a winding traversed by the current of the working motor, and by another winding connected to a source of direct current at constant potential acting in opposition to the first winding.

(5) A modification of the regulation in which the regulation of the choking coil is effected simultaneously by the current and the potential of the working motor, one of the direct current windings being included in the circuit and the other being connected parallel to the armature.

(6) In the regulation claimed by Claims 1 to 5, the use of a regulatable choking coil which is divided in such a manner that the electro-motive forces induced in the direct current windings work in opposition for the purpose of avoiding irregularity of the alternating current curve and prevent the formation of an alternating potential in the direct current circuit.

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers will be given.

Short Notices.

The Colliery Manager's Pocket Book, 1904. The Colliery Guardian Co, Ltd., Furnival Street, E C.; 2s. A diary and year book which should be in the hands of every colliery manager, station engineer, and electrician. There is a useful section on electrical engineering.

Hazell's Annual, 1904. Hazell, Watson & Viney, 52 Long Acre, W.C.; 3s. 6d. We welcome this annual to our office list of books. It condenses information always useful in business routine. The particular issue is prefaced with a valuable index.

Motoring Illustrated Annual and Motorist Year Book, 1904. Motoring Illustrated, 9 Arundel Street, Strand; 5s. 6d. A wealth of valuable data on motors and motor people is compressed into the 400 odd pages of this book. Useful hints on electric cars are given.

Technics. A magazine for Technical Students. George Newnes, Ltd., Strand, W.C.; monthly 9d. The first three numbers of this magazine are before us, and would have received notice earlier, but for lack of space. The magazine contains articles by experts, on all technical subjects, and should prove valuable to all classes of students.

The World's Work, March, 1904. W. Heinemann, 21 Bedford Street, W.C.; monthly 1s. The March issue contained an interesting article on mining by electricity. The magazine can always be looked to for a concise popular account of many scientific and engineering developments.

The Penrose Pictorial Annual. The Process Year Book, 1903-4. A. W. Penrose & Co, 109 Farringdon Road, E.C.; 7s. 6d. A valuable compendium of information on process work. A book of extreme value to advertising firms and manufacturers who prepare their own pamphlets, circulars, etc.

Geometry for Technical Students.

By E. H. Sprague. Crosby, Lockwood & Son, London. 1s. net.

This, an introductory text book to pure and applied geometry, is a useful little book which can with confidence be recommended to the notice of young engineering students. It is to be feared that too little attention is paid to the teaching of this important subject, and that many electrical engineers do not realise the importance of the study of geometry, and the many ways in which it may be applied in the graphical treatment of electrical problems. In the book before us the common-sense method of treating the subject has been adopted, and it is quite refreshing to come across a book on geometry which does not follow the old-fashioned and out-of-date methods of dealing with pure and practical geometry. The main idea of the author appears to be that of bringing before the student the fundamental principles of pure geometry which are necessary in practical plane geometry and in the mensuration of surfaces and solids, and as it is not intended primarily for students preparing for some examination, the author has been free to introduce common-sense methods which experience in teaching the subject has proved the most satisfactory way of dealing with the subject.

The Factory Manager and Accountant.

Some Examples of the latest American Factory Practice. Collected and arranged by Horace Lucian Arnold. London: *The Engineering Magazine*, 1903. 20s. nett.

During the last few years a considerable amount of attention has been devoted to the organisation of improved systems of factory management in this country. This development is largely due to the new conditions that have arisen. Industrial establishments are coming more and more into the hands of large corporations, and the systems of management that were perfectly suitable when owners and managers were able to personally supervise and control all the operations, are no longer suited to prevailing conditions of work. It is now necessary to delegate duties to subordinates who, in many cases, are charged with responsibilities as onerous as those formerly falling upon principals and general managers. The difficulty of efficiently controlling the managers, or foremen, of the several departments in a large manufactory, and of co-ordinating the whole of the operations conducted, has made the modern system an absolute necessity. In the work now before us we have a very useful contribution to literature on this subject. The first two chapters are of introductory character, dealing with the principles of "Factory Routine Organisation and Cost-Finding," and with "Advances in Factory Accounting." The remainder of the volume describes in full detail several complete systems adopted in the United States, and in it are given all the necessary forms employed in the application of the systems in question. The cost-finding and commercial blanks are accurately reproduced in arrangement, the actual size of each form in inches being stated, together with its colour and the material upon which it is printed. Further, the function and exact manner of using each form is fully detailed so that the reader may understand its scope and proper employment, and make an estimate of its probable value if applied in his own practice. This is essentially a practical work, and one which we may confidently recommend to all who are concerned in the management of industrial establishments.

The Grant and Validity of British Patents for Inventions.

By James Roberts, M.A., LL.B., A.I.E.E. John Murray, London. 25s. net.

In this handsome volume the author seeks to provide inventors with a practical guide to the preparation of specifications for letters patent, by instructing them on the fundamental principles of law involved in these documents, and on the methods followed by the courts in construing them. Every inventor is naturally anxious that his patent should be valid, and that the specifications should not present any weak points, where an attack might prove dangerous; but as a general rule such a person is not familiar with the law on the subject, and is unaware of the great number of pitfalls set in his path. In such a case he must either take professional advice, or make himself acquainted with the legal principles before drafting his specification. As a general rule the former alternative is the wiser course to follow, as patent law cannot be learned in a day, but some inventors are sufficiently intelligent to follow and appreciate accurate instructions on this intricate subject, and persons of this class will find much useful information in the present volume.

Although the book is bulky, containing altogether 610 pages, excluding the index, the discussion of the law as to the grant of patents is confined entirely to Part I., and occupies only 178 pages. The remainder of the volume is devoted to abstracts of important cases, serving as illustrations of the principles laid down in Part I.; and to the different statutes and Patent Office Rules, so far as they bear on the grant of patents. The author does not write primarily for lawyers, and therefore does not discuss actions in Court for infringements of patents. All he is concerned with is the grant, and his discussion is therefore confined to questions arising under that head—Who may obtain a patent? What is patentable, and what is not? What steps must be taken to obtain a patent, and on what grounds may other persons oppose the grant? These matters and others of equal importance are discussed in detail, and in some respects the author's treatment is fresh and original. There is certainly a wealth of illustration of the fundamental principles, and the explanations are always clear. To lawyers who turn to this volume, possibly the part which will appeal most, is that which gives the abstracts of leading cases, as this should be useful to them for purposes of reference.

In view of the fact that the volume is intended for inventors, who are rarely wealthy persons, it may be questioned if it was wise to make the work so costly by including so much that can easily be obtained elsewhere. Thus, Part III. and the appendix cover more than 120 pages, but include nothing but statutes, rules, forms, etc., which are all set out in the same large type as is used in Part I. This, however, is a question for author and publisher to settle as they think best, and certainly in its present form the volume has a very attractive appearance.

The Elements of Electrical Engineering.

A First Year's Course for Students. 2nd Edition, Revised. By TYSON SEWELL, A.I.E.E. Crosby Lockwood and Son, London. Price 8s.

The fact that Mr. Sewell's book has run through a first edition in something less than a twelvemonth, is sufficient evidence of the fact that it has been found useful by a large number of students. We certainly consider it one of the best elementary manuals in existence. It is clearly written, and although at times the author's efforts to come down to the mental level of his reader are dangerously near the line which differentiates the scientific treatment of a subject from a mere popular exposition, we do not think that this line has been overstepped. In the first edition, the author dealt with electrical units, the effects of a current, the magnetic circuit; primary cells and the principles of electro-chemistry; secondary cells; measuring instruments; the measurement of p.d., capacity and current; magnetic measurements; arc and incandescent lamps, and continuous current generators and motors. To the above are now added three entirely new chapters on the general principles of alternate current work, alternators, transformers, synchronous motors and polyphase machinery. Having already given expression to our appreciation of the excellence of this manual, we shall, in the remaining space at our disposal, briefly refer to one or two minor blemishes in the book. At the foot of p. 73, in dealing with permeability, the author states that "nickel and cobalt have slightly different values to (from?) air," apparently forgetful of the fact that both these metals are very strongly magnetic. In most of the diagrams of magnetic fields, no attempt is made to exhibit *refraction* of the lines. Fig. 178 is wrong in showing the lines above the conductor as concave towards it instead of *convex*. In Fig. 210, the power curve should be a pure sine wave touching the axis of time, and not one with rounded tops and sharp cusps at the bottom, as shown.

Elements of Electromagnetic Theory.

By S. J. BARNETT, Ph. D. The Macmillan Co., New York and London. Price 10s. 6d.

The student of pure electrical science has now a large number of text books to select from, not only as regards the more elementary portions of the subject, but also the more advanced. The book under review is the latest addition to the advanced type of text book. The method according to which the subject matter is arranged is similar to that followed by most other books of a similar kind, electrostatics being dealt with first, then electrokinetics, magnetism, and electromagnetism. The book is intended for the advanced student of mathematical physics, and the author in his preface disavows any intention of referring to the practical aspect of the subject. The style is clear and vigorous, and the student who has studied the book should be in a position to tackle Maxwell's treatise, and J. J. Thomson's and Heaviside's works. Following Heaviside, the author adopts throughout the "rational" system of units. It seems a pity that there is little prospect of the general adoption by "practicians" of this system; but in view of this fact, it is a still greater pity that a certain section of pure mathematical physicists should be drifting into a system of units totally unknown to most electrical engineers. References to original papers and other treatises on the same subject form useful features of the book. In dealing with ballistic work, the author adopts as a standard formula that which applies to the needle type of instrument, although nowadays this type must be regarded as obsolete. The omission of the investigation regarding the damping correction seems strange, in view of the large number of purely academical problems which receive detailed treatment. On p. 324, line 8 from foot of page, "first" should read "second."

In view of the immense importance of the electron theory, one would naturally expect, in a modern book on electromagnetic theory, to find some account of this subject. The only reference to it occurs on p. 244, where only an extremely meagre and unsatisfactory outline of the theory is given. In this respect the book is distinctly disappointing, and if the author had devoted more attention to the more recent developments of electrical science, such as the investigations relating to cathode rays, X-rays, canal rays, the Zeeman effect, radio-activity, &c., instead of devoting so much space to problems whose solutions are to be found in numerous other text books, he would have produced a book far better suited to the needs of the time.

Handbuch der Elektrotechnik.

(Treatise on Electrotechnology.)

HEINKE. Vol. I.: Electrophysics. Part I., by C. HEINKE, price 10 marks. Parts II. and III., by C. HEINKE and H. EBERT respectively, price 25 marks. Published by S. Hirzel, Leipsic.

This is the introductory volume of this great work, of which volumes IV., IX., and XII., dealing with Alternate Current Generators, Electric Motors and Power Transmission, and Telegraphy and Telephony respectively, have already appeared. The first part opens with a most interesting historical sketch of the development of the science of electro-magnetism, from the work of Gilbert in 1628 to the year 1900. He next discusses at considerable length, and in a most able manner, the value and functions of scientific theories generally.

Then, after dealing shortly with the various theories antecedent to that of Faraday and Maxwell, the latter is set forth, including Oliver Lodge's developments. He then discusses the conceptions of cyclic motions introduced by Helmholtz and Hertz, and the ionisation theories of Arrhenius, Ostwald, Nernst, and others. A descriptive account of electromagnetic phenomena concludes the first part.

The second part, which is by far the longest of the three, opens with a detailed treatment of electric current phenomena—direct and alternating. No formal division is made between direct and alternating current phenomena. The general conditions are discussed which determine the relations between current, resistance and E.M.F., either direct or alternating. The method is somewhat novel in a text-book, but thoroughly logical and instructive. Electric waves are then dealt with, after which follow two exhaustive chapters on conduction and conductors—the first dealing with metallic conduction, and the second with convective conduction (electrolytic and gaseous). A considerable amount of space is devoted to the important and interesting subject of "electric valves." The last division of this part is devoted to the general phenomena of ferro-magnetism and the consideration of ferro-magnetic materials, including the effects of variation in chemical constitution and physical conditions. Part III. is devoted to the mathematical theory of electromagnetism. A very interesting chapter deals with the significance in electrical theory of Helenhaltz's cyclical motions.

Modern Electric Practice.

Editor, PROF. MAGNUS MACLEAN, M.A., D.Sc. Vol. 1. London: The Gresham Publishing Co. Price 9s.

In a very handsomely got up volume, published by the Gresham Publishing Co., we have presented the first of a series of six volumes, entitled, "Modern Electric Practice," under the general editorship of Prof. Magnus Maclean. As is pointed out, the subject of modern electric practice is now so extensive that it is impossible for any one individual to deal effectively with all its ramifications. In order, therefore, to treat the subject thoroughly and efficiently, the co-operation of a number of authors has been secured, each being an expert in some special branch of the subject, and whose names are an ample guarantee of the subject matter being accurate and up-to-date.

The volume before us is divided into five sections, dealing respectively with electric and magnetic measurements, alternating current measurements, continuous current generators, alternating current generators, and the continuous current motor. Following three chapters, in which electrical and magnetic units and their relations to the C.G.S. units are clearly explained, we find three devoted to resistance measurement, ammeters and voltmeters, and supply meters. No attempt has been made to describe in detail all the varieties of methods and instruments employed, but only those best suited for the various requirements. Amongst the latter we find a good description of the Addenbrooke Electrostatic Voltmeter, but regret that the application of this instrument to alternating current measurements has not been fully discussed. . Again, in view of its extensive application in commercial testing, a full description of the Crompton or other form of Potentiometer would be desirable. The chapter on magnetic measurements might with advantage have included a description of some of the well-known magnetic testing instruments such as the Ewing magnetic balance and permeability bridge. The first section concludes with a description of primary batteries in which, however, we find no reference to dry cells, now so extensively used in electric testing, nor to the Cadmium standard cell, which may eventually supplant the Clark cell.

The second section commences with a description of the Duddell oscillograph, and then follow chapters on the sine wave, self-induction, capacity, and electrical resonance, all of great importance in connection with alternating currents. Descriptions of alternating current ammeters, voltmeters, wattmeters, and energy meters, and a short but lucid chapter on two and three-phase currents complete this section. In dealing with continuous current generators no attempt has been made to consider any but typical modern traction and power generators, nor to discuss the theory of the dynamo, the reader being referred for this to the various well-known standard works on the subject. The section contains chapters on the design of armatures, field magnets, commutator and brush gear, and one giving examples of modern generators, many of which have been designed by the authors of the section. Alternating current generators have eight short chapters devoted to them, which treat of single-phase, two-phase, three-phase, and induction generators. The last section is devoted to the design and applications of the continuous current motor.

The treatment of the various sections in the volume from beginning to end exhibits the impress of practical experience, and is by no means a synopsis of various works already published on the subject. The figures and diagrams have been beautifully reproduced, and in all cases are clear and distinct. We look forward with interest to the publication of the remaining volumes, and refer our readers to our advertisement pages, where the scheme for providing the work will be found, together with an order form.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whole will form an index guide of considerable importance and value.

Power.

Articles.

Light, Heat and Power in a large Apartment Building.	*West. Elec.* 30/1/04.
The Manchester Corporation Power Stations. T. W. Chubb. (Serial II.).	*Power, Feb.* '04.
Cockerill Gas Engines. E. Guarini.	*Power, Feb.* '04.
Installation and Care of Electric Motors. S. L. Barriett.	*Power, Feb.* '04.
Protecting Electric Conductors. G. Sattler. (Concld. 15/2/04.)	*Elektro. Runsch.* 1/2/04.
Electricity in the Linz (Austria) Imperial & Royal Railway Workshops. R. Dub and E. Suchy.	*Elek. Zeit.* 4/2/04.
Electric Drive for Machine Tools. P. A. Bates.	*Canadian Mfg.* 5/2/04.
*Measurement of distributed leakage on Transmission lines. F. F. Fowle.	*Elec. Wld. & Eng.* 6/2/04.
Calculating the Capacity of Aerial Conductors and Cables. L. Lichtenstein. (Concld. 18/2/04).	*Elek. Zeit.* 11/2/04.
Lightning at Close Quarters. T. H. Hadfield.	*Elec. Rev.* 12/2/04.
Electrical Winding Engines.	*Eng.* 12/2/04.
High Pressure Power in the Housatonic.	*Elec. Wld. & Eng.* 13/2/04.
*The Frequency Changers at Montreal. B. A. Behrend.	*Elec. Wld & Eng.* 13/2/04.
*Calculation of Transmission Lines	*Elec. Rev. N.Y.* 13/2/04.
*Electrical Equipment of Sachett & Wilhelms Printing Co.	*Elec. Rev N.Y.* 13/2/04.
*Application of Graphics to Power House Location. S. Diament.	*Elec. Wld. & Eng.* 13/2/04.
The Manufacture and Use of Peat Fuel.	*Mech. Rev.* 15/2/04.
Aluminium Power Transmission Lines. G. Dary.	*L'Electn.* 20/2/04.
De Forest Wireless Telegraph System. G. A. Montpellier.	*L'Electn.* 20/2/04.
Grounding of Constant Potential Systems. S. B. Wood.	*Elec. Wld. & Eng.* 20/2/04.
*Efficiency Test of 1,250 kw. Steam Turbine. A. M. Mattice.	*Elec. Wld. & Eng.* 20/2/04.
South Norwalk Electric Works. A. E. Winchester.	*Elec. Wld. & Eng.* 20/2/04.
Electric Power in Tanneries. G. E. Walsh.	*Elec. Rev. N.Y.* 20/2/04.
Kubel Electricity Works. E. Collischonn.	*Elek. Zeit.* 25/2/04.
*A 20,000 Volt Transmission Plant. A. J. Bloemendal	*Eng* 26/2/04.
Seattle Municipal Light and Power Plant. R. E. Heine.	*Elec. Wld. & Eng.* 27/2/04.
A Composite Plant at Bloomsbury, Pa. L. S Levy.	*Elec. Wld. & Eng.* 27/2/04.
Service Plant at St. Louis.	*Elec. Wld. & Eng.* 27/2/04.
H.T. Plants in Roumania and Switzerland. F. C. Perkins.	*Elec. Rev. N.Y.* 27/2/04.
Mallersdorf Electricity Works. G. Sabel.	*Elek. Anzr.* 3/3/04.
The Reidler-Stumpf Steam Turbines. W. Rappaport.	*Elec. Rev.* 4/3/04.
Hydro-Electric Installation at Newry.	*Eng.* 4/3/04.

Papers before Societies.

Modern Methods of Operating Machine Tools Electrically. P. A. Bates.	*Eng. Soc. Columbia Univ.* 2/2/04.
The Distribution of Electricity in Shipyards. J. A. Anderson.	*Inst.E.E. Newcastle.* 8/2/04.
Gas Engines. H. Allen.	*Assoc. Eng. in Charge.* 10/2/04.
Electric Transmission from Water Power.	*Liverpool Eng. Soc.* 10/2/04.
The Electricity and Destructor Station at Plumstead. T. S. Nash.	*Inst.C.E.* 12/2/04.
*New Methods of Electrical Winding Gear for Collieries. M. Georgi.	*Inst.E.E. Glasgow.* 13/2/04.
*The Forms of Turbines suitable for Low Falls. A. Steiger.	*Inst.C.E.* 16/2/04.
The Equipment of an Engine Test House. R. K. Morcom.	*Berlin Inst.E.E.* 17/2/04.
Electric Transmission of Power in Workshops. G. T. Irwin.	*Rugby Eng. Soc.* 18/2/04.
Electricity on Board Ship. D. K. Roberts.	*Inst. Marine Eng.* 24/2/04.
*European Practice in H. T. Transmission Lines. G. Semenza.	*Amer. Inst.E.E.* 26/2/04.
Conductivity of Atmosphere at High Voltages. H. J. Ryan.	*Amer. Inst.E.E.* 26/2/04
Power Distribution in Shipyards. Anderson. (Discussion).	*Inst.E.E. Newcastle.* 29/2/04.
*Electrical Coal Cutting Machinery. S. Mavor.	*Glasgow Inst.E.E.* 8/3/04.
Electrical Equipment of an Engine Works and Shipyard. H. O. Wraith.	*Leeds Inst.E.E.* 10/3/04.
The Supply of Electricity to Small Irish Towns. T. Tomlinson.	*Dublin Inst.E.E.* 10/3/04.

Lightning and the Science of Protection therefrom. A. Hands.	*Camera Club.* 10/3/04.
Switchgear for Traction and Transmission. J. W. Bell.	*Manch. Inst.E.E.* 11/3/04.
The Development of Internal Combustion Engines. T. B. Bramley.	*Coventry Eng. Soc.* 12/2/04.

Traction and Transport.

Articles.

A Link in the London Suburban Tramway System.	*Try. & Rly. Wld. Feb.* /04.
Baker Street & Waterloo Railway.	*Lt. Rly. & Try. Jrnl. Feb.* /04.
Electrically Driven Hydraulic Passenger Lifts.	*Engr.* 5/2/04.
Three Wire direct current Railway System.	*Elec. Wld. & Eng.* 6/2/04.
Magnetic Ignition for Explosion Motors. A. Soulier.	*L'Ind. Elec.* 10/2/04.
The Paris Metropolitan Railway. (Serial, continued).	*La. Rev. Tech.* 10/2/04.
Electric Railways in Italy. P. Lanino.	*Elek. Zeit.* 11/2/04.
Automatic Railway Signalling.	*Engr.* 12/2/04.
The Electrification of the Metropolitan Railway. (Serial).	*Eng.* 19/2/04.
*Paris Metropolitan Railway. (Contd.) E. Loyselles.	*La Rev. Tech.* 25/2/04.
Electrification of the Metropolitan Railway. (III.)	*Eng.* 26/2/04.
*Electric Locomotives and Freight Trains. H. W. Leonard.	*Elec. Wld. & Eng.* 27/2/04.
*Fribourg-Morat-Anet Electric Railway. (Concld. 5/3/04.) S Herzog.	*L'Eclair Elek.* 27/2/04.
The Rail Return. E. Guarni.	*L'Electn.* 27/2/04.

Papers.

General Notes on the London Traffic Problem. J. & J. Reynolds.	*Civ. Mech. Eng. Soc.* 4/2/04.
Electric Automobiles. F. Bates.	*Birm. Univ. Eng. Soc.* 11/2/04.
* Manchester Tramway Equipments. J. M. McElroy.	*Inst.E.E. Manch.* 16/2/04.
Electric Power for Railways. B. S. Lanphear.	*Iowa Eng.Soc.* 22/1/04
Conduit and Surface Contact Systems. G. Balfour.	*Liverpool Eng. Soc.* 24/2/04.
*New Developments in Electric Railways. A. Siemens.	*Royal Inst.* 26/2/04.
*The Alternate Current Railway Motor. C. P. Steinmetz.	*Amer. Inst.E.E.* 29/2/04.
*Speed Torque Characteristics of the Single Phase Repulsion Motor. W. I. Slichter.	*Amer. Inst.E.E.* 29/2/04.
Notes on Automobiles. B. Hopps.	*Rugby Eng. Soc.* 3/3/04.
*The Railway Electrification Problem, and its Probable Cost for England and Wales. F. F. Bennett.	*Inst.E.E.* 10/3/04.

Lighting and Heating.

Articles.

Relative Maximum of Luminous Power in Direct Current Arc Lamps. E. Richter.	*Elek. Zeit.* 4/2/04.
Triplex Arc Lamps (Cld. 7/2/04) F. Hoppe.	*Elek. Anzr.* 4/2/04.
Direct Reading Ohmmeter. Dr. H. Sack.	*Elektro. Runsch.* 15/2/04
Installation Material in Conformity with Official Regulations. S. F. v Gaistberg.	*Elek. Zeit.* 25/2/04.
*The Chicago Theatre Fire. E. O. Sachs.	*Eng.* 26/2/04.
Electrical Fires. E K. Scott.	*Elec. Rev.* 4/3/04.
Electric Light in Photographic Studios. P. Simon.	*L'Electn.* 5/3/04.

Telegraphy and Telephony.

Articles.

The Microphone in long distance Telephone service. Stosberg.	*Elek. Zeit.* 4/2/04.
*The New Trunk Telephone Exchange.	*Elect.* 5/2/04.
On the Wave Length of Free Vibrations in Autenual. Dr. J. E. Ives.	*Elec. Wld. & Eng.* 6/2/04.
Multiple Telegraphy. G. Dubreuil.	*L'Elec.* 6/2/04.
Wireless Telegraphy. R. G. Blaine (Serial contd.).	*Elec. Eng.* 12/2/04.
On Sending and Receiving Devices for the Electrical Transmission of Photographs. A. Korn.	*Physik. Zeit.* 15/2/04.
Wireless Telegraphy. R. G. Blaine. (Serial contd.).	*Elec. Eng.* 19/2/04.
Berlin Printing Telegraph Station. F. C. Perkins.	*Electricity, N.Y.* 24/2/04.
Bull's System of Tuned Wireless Telegraphy. K. Priemer.	*Helios.* 24/2/04.
The Steljes Teletyper. Lindow.	*Elek. Zeit.* 25/2/04.
Wireless Telegraphy (Contd.) R. G. Blaine.	*Elec. Eng* 26/2/04.
Municipal Telephones. (II.)	*Elec. Eng.* 26/2/04.
Telephone Transmitters. (Serial. VI.) A. V. Abbott.	*Elec. Wld. & Eng* 27/2/04.
*The Lonnier System of Machine Telephony.	*Elec. Rev. N.Y.* 27/2/04.
Brighton Telephones.	*Elec. Eng.* 4/3/04.
Municipal Telephones. (III).	*Elec. Eng.* 4/3/04.
Baudot - Picard Submarine Cable System. (Serial.)	*L'Electn.* 5/3/04.

Papers.

Improvement in the Telephone Service. G. W. Wilder.	*Wisconsin Indep. Telep. Assoc.* 10/2/04.
Legislative Prohibition of Discrimination in Telephone Rates. J. C. Harper.	*Wisconsin Indep. Telep. Assoc.* 10/2/04.
*A New Method of Detecting Electrical Oscillations. J. A. Ewing and L. H. Waller.	*Royal Soc.* 11/2/04.
*The Independent Telephone Movement. J. B. Hoge.	*Ohio Indep. Telep. Assoc.* 17/2/04.
Party Lines. J. B. Rhodes.	*Ohio Indep. Telep. Assoc.* 17/2/04.
Consolidation. D. Prewitt.	*Ohio Indep. Telep. Assoc.* 17/2/04

Electro-Chemistry.

Articles.

The Electrical Manufacture of Nitrates. A. Wodon.	*L'Electn.* 27/2/04.

Papers.

Formation of Hypochlorites. S. S. Saddler.	*Amer. Electro-Chem. Soc.* 5/2/04.
Composition and Reduction of Voltages. J. W. Richards.	*Amer. Electro-Chem. Soc.* 5/2/04.
Theory of Electromotive Forces. R. Gahl.	*Amer. Electro-Chem. Soc.* 5/2/04.
Recent Advances in Electro-Chemistry. (Lecture I.). B. Blount.	*Soc. Arts.* 12/2/04.

Electro-Physics.

Articles.

Novel Influence Machines. W. Wolf. (Concld. 10/2/04.)	*Helios.* 3/2/04
On the Circular Diagram of the Repulsion Motor. F. Creedy.	*Elec. Rev.* 5/2/04.
The Magnetic & Electrostatic Separation of Metals.	*L'Eclair Elect.* 6/2/04.

The Edison Accumulator.	*L'Eclair Elect.* 6/2/04.
Radiation and Radio Activity. L. Bell.	*L'Ind. Elec.* 10/2/04.
Radio-Activity and Radiation. G. B. Whitehead.	*Elec. Wld. & Eng.* 13/2/04.
Bruger Potentiometer.	*L Electr.* 13/2/04.
Experiments with Holtz Machines. S. Sheldon.	*Elec.Rev.N.Y.* 13/2/04.
Generalization of Electro-magnetic "Self-Interrupters" and their Use for Acoustical Demonstrations. J. J. Taudin-Chabot.	*Physik. Zeit.* 15/2/04.
Electrical Analogon of Diamagnetism. L. Puccianti.	*Physik. Zeit.* 15/2/04.
On the Cause of Conductivity of Phosphorous Air. F. Harms.	*Physik. Zeit.* 15/2/04.
Divergence of Electroscope Sheets in the Vacuum. S. Guggenheimer & A. Korn.	*Physik. Zeit.* 15/2/04.
Novel Rays or a Novel Emanation. J. J. Taudin-Chabot.	*Physik. Zeit.* 15/2/04.
* Can Electrons move at the Velocity of Light? P. Hertz.	*Physik. Zeit.* 15/2/04.
The Circle Diagram of the Repulsion Motor. (II). F. Creedy.	*Elec. Rev.* 19/2/04.
Notes on Electro Statics. H. E Harrison.	*Elec. Times.* 25/2/04.
*Radio-Activity. F. Soddy. (Serial concluded).	*Electn.* 26/2/04.
Notes on Monophase Motors. A. Blondel.	*L'Eclair Elek.* 27/2/04
* Resistance and Temperature. G. König.	*Elek. Anzr.* 28/2/04.
*The Circle Diagram of the Repulsion Motor. (III., concld.) F. Creedy.	*Elec. Rev.* 4/3/04.
Electrons and Meteorology. J. Don.	*Elec. Rev.* 4/3/04.

Papers.

*Electrical Methods of Measuring Temperature (Lecture I). Prof. H. L. Callendar.	*Royal Inst.* 26/2/04.
The Employment of Capacities. F. Drouin.	*L'Elec.* 6/2/04.
Theory of Amphoteric Electrolytes. Prof. J. Walker.	*Royal Soc.* 18/2/04.
Atmospherical Radio-Activity in High Latitudes.	*Royal Soc.* 18/2/04.
Modern Conceptions of Matter. A. Maclean.	*Glasgow Tech. Coll. Sci. Soc.* 20/2/04.
Electromotive Force in Mammalian Non-Medullated Nerve. N. H. Alcock.	*Royal Soc.* 25/2/04.
*On Mechanical and Electrical Response in Plants.	*Royal Soc.* 25/2/04.
A Quartz Thread Vertical Force Magnetograph. Dr. W. Watson.	*Phys. Soc.* 26/2/04.
On Stresses in a Magneto Static Field. G. W. Walker.	*Phys. Soc.* 26/2/04.
Electrical Methods of Measuring Temperature. Prof. Callendar. (Lecture II).	*Royal Inst.* 2/3/04.
Some Laboratory Notes of the past Six Months. President's Address.	*Röntgen Soc.* 3/3/04.
Influence of Illumination on the Conductivity of Selenium. N. Heschus.	*Jrnl. Russian Phys.-Chem. Soc.*
Conditions necessary for the Formation of Electric Arcs. Mitkiewicz.	*Jrnl. Russian Phys.-Chem. Soc.*

Electro-Metallurgy.

Articles.

Progress in Electro-Chemistry and Electro-Metallurgy in 1903. J. B. C. Kershaw (Concluded, 12/2/04).	*Elec. Rev.* 5/2/04.
Electric Production of Steel.	*L'Electn.* 20/2/04.

Papers.

Electrical Furnaces. G. H. Slansbie.	*Birm. Tech. School Metall. Soc.* 13/2/04.
The Electrolytic Analysis of Gold. P. M. Perkin and W. C. Prebble.	*Faraday Soc. March Meeting.*

Students.

Articles.

The A. C. Series Motor. F. D. Newbury.	*Electric Club Jrnl* 1/2/04.
Technical Instruction in Germany. W. G. Rhodes.	*Elec. Rev.* 12/2/04.
Inducements to Enter Light Current Engineering. J. B. Baker.	*Elec.Rev.N.Y.* 13/2/04.

Papers.

On Small Private Installations. H. Purle.	*Inst.E.E. (Stdnts.)* 10/2/04.
*Trans-Atlantic Engineering Schools. Prof. R. M. Walmsley.	*Inst.E.E.* 11/2/04.
The Testing of Alternate Current Machinery. R. J. Kaula.	*Inst.E.E. (Stdnts.)* 17/2/04.
Automatic Railway Signalling. E. Fisher.	*Inst.E.E. (Stdnts.* 24/2/04.
Boiler House Design. L. G. Crawford.	*Inst.C.E. (Stdnts.)* 26/2/04.
*The Determination of Correct Proportion of Condensing Plant in a Central Station. P. V. Hunter.	*Inst.E.E. (Stdnts.)* 2/3/04.
Practical Notes on Storage Batteries. G. C. Allingham.	*Jun. Inst. Eng.* 4/3/04.
The Premium System of Payment for Labour. W. G. Barrister and A. F. Yarrow.	*Inst.C.E. (Stdnts.)* 11/3/04.

Manufacturers.

Articles.

The Preparation of Estimates.	*Eng.* 5/2/04.
The Cable Works of Messrs. Pirelli & Co., Milan.	*Elec. Rev.* 5/2/04
The Reidler Stumpf Steam Turbines.	*Eng.* 12/2/04.
On Asynchronous Motors. W. Pensabene.	*Elec. Eng.* 12/2/04.
* Progress in the Design of Direct Current Machinery. E. Schulz.	*Elek. Anzr.* 14/2/04.
* A Law relative to the Cost of Testing and Supervising Electric Plants. Dr. E. Möllendorff.	*Elek. Anzr.* 15/2/04.
Electric Controlling Apparatus Siemens Schuckert Works. K. Klein.	*Elek. Anzr.* 18/2/04.
The Dissymmetrical Attraction of the Rotor in Asynchronous Motors. J. Rey.	*L'Eclair Elect.* 20/2/04.
Progress in Designing Induction Motors. E. Schulz.	*Elek. Anzr.* 28/2/04.
*Dynamo Construction in Germany (Serial, continued).	*La Rev. Tech.* 25/1/04
•New Polyphase Transformers. G. Isaac.	*L'Electn.* 5/3/04.

Papers.

Commutation of Continuous Current Generators and Motors. G. A. Neild and P. E. Banting.	*Rugby Eng. Soc.* 4/2/04.
The Steam Turbine. F. C. Porte.	*Inst.E.E. Dublin.* 11/2/04.
Notes on Steam Engine and Dynamo Testing. R. Morcon.	*Inst.E.E. Birmhm.* 17/2/04.
Some Experiments with large Gas Engines. W. Emmott.	*Inst.E.E. Leeds.* 18/2/04.
Dynamo and Motor Testing. C. F. Smith.	*Civ. & Mech. Engrs Soc.* 3/3/04.
British Competition and Manufacture. M. Pickstone.	*Glasgow Tech. Coll. Sci. Soc.* 5/3/04.
•The Rated Speed of Electric Motors, as Affecting the Type to be Employed. H. M. Hobart.	*Inst.E.E.* 10/3/04.

Central Station Practice.

Articles.

Graphite Resistances. A. Hopfelt.	*Elek. Anzr.* 4/2/04.
Armoured Cables. J. Schmidt. (Concld. 18/2/04).	*Helios.* 10/2/04.
*Care and Maintenance of Storage Batteries. (IV.). E. Lyndon. (V.), 20/2/04.	*Elec.Rev.N.Y.* 13/2/04.
Apparatus for Cutting-out Transformers in Alternating Current Circuits. E. W. Ehnert.	*Helios.* 18/2/04.
Cylinder Condensation and Valve Leakage in Steam Engines. Prof. J. T. Nicolson. (Serial IV.).	*Power, Feb.* /04.
Liquid Fuel. W. H. Booth.	*Power, Feb.* /04.
Turbines and Superheated Steam. W. H. Booth.	*Elec. Rev.* 26/2/04.
The Advantages of Boosting. F. Broadbent.	*Elec. Rev.* 26/2/04.
*Care and Management of Storage Batteries. E. Sugdon (Serial continued)	*Elec. Rev. N.Y.* 3/6/04.

Papers.

Fuel Testing.	*Inst. Marine Eng.* 1/2/04.
Simple Instructions to Engine and Boiler Attendants. H. G. Scott.	*Cleveland Inst. Eng.* 1/2/04.
*Prime Movers for Central Stations. C. A. Smith.	*Inst.E.E. Birmhm.* 6/2/04.
The Gas Engine for Central Station Service. R. D. Mershon.	*N.Y. Elec. Soc.* 17/2/04.
*Alternators in Parallel. H. Bohle (Adj. Disc.).	*Inst.E.E. Leeds.* 18/2/04.
Water Tube Boilers for Stationary Work A. Hobbs.	*Manch. Assoc. Eng.* 27/2/04.
Regulation by Impedance Coils. C. F. Proctor.	*Inst.E.E. Newcastle.* 29/2/04.
High Speed Engines. W. Crawford.	*Assoc. Eng. in Charge.* 9/3/04.
Steam Boiler Failures.	*Liverpool Eng. Soc.* 10/3/04.
The Three Wire System.	*West Hartlepool Sci. Soc.* 12/3/04.

Electrical Work in the Shops.

Articles.

Electrical Work in Shops. E. K. Scott.	*Elec. Rev.* 26/2/04.

Trade and Commerce.

Papers.

The Present Position of Trade in South Africa. B. H. Morgan.	*Birm. Assoc. Mech. Eng.* 5/3/04.
British Competition and Manufacture. H. Pickstone.	*Glasgow Sci. Tech. Soc.* 5/3/04.

Finance and Legislation.

Papers.

*Should Electric Supply Undertakings Hire Motors. S. E. Britton.	*Inst.E.E. Glasgow.* 9/2/04.

◆

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, *with names and addresses of manufacturers, will be given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.*

◆

Power.

Dynamos and Motors. ERNEST SCOTT & MOUNTAIN, LTD., Close Works, Newcastle-on-Tyne. We have received from this firm an illustrated list of Central Station plant, including engines, dynamos and motors, and their applications The firm make a speciality of mining appliances, in the shape of pumps, hauling engines, locomotives and disc coal cutters.

THE TANGYE TOOL & ELECTRICAL CO., LTD., Birmingham. The dynamos, motors and motor starters of this firm are described in a neatly prepared booklet. Continuous current motors, of the open and enclosed type, are constructed up to 50 h.p. The method of winding is described by illustrations and the sizes of the machines are given. The same firm have favoured us with a copy of their hydraulic machinery.

J. H. HOLMES & CO., Portland Road, Newcastle-on-Tyne. The sixty page booklet issued by this firm is an excellent tribute to the printer's art in the production of high-class price lists. The illustrations are of an elaborate character, and clearly depict the full details of the firm's manufactures in the shape of the Lundell and Castle motors. The application of these motors to newspaper printing has been made a special study of, and the Holmes-Clatworthy patented system is exploited by the firm. The printing section occupies some eighteen pages of the list, so that its importance can be gathered from this fact.

CLARKE, CHAPMAN & CO., LTD., Victoria Works, Newcastle-on-Tyne, have favoured us with a cover containing leaflets which describe their standard dynamos and motors. Particulars are also given of high speed engines, condensing plant, winches, capstans, locomotives, and projectors. The specialities of the firm cover a wide range, and are chiefly applicable for ship and dockyard use. The leaflets are carefully arranged, while the illustrations are everything that could be desired.

THE POWER PLANT CO., LTD., 20 New Bridge St. E.C., has sent us a number of leaflets in cover describing their specialities in electric hand-drilling machines, air compressors, pneumatic hammers, and the "Orvo" valveless reciprocating pumps.

THE LAHMEYER ELECTRICAL CO., LTD., 109 New Oxford St., W.C., have a number of interesting specialities in electrically driven centrifugal pumps and air compressors, particulars of which are given in two illustrated circulars. We give a description of one of the former in the Manufacturers Section, page 304, while a special form of mine pump installed by the same firm is described in Mr. Allen's article, "Electricity Applied to Mining," etc., on page 240.

THE INGERSOLL-SERGEANT DRILL CO., 114 Queen Victoria St., E.C., are well known for their specialities in air compressing plant. Their comprehensive catalogue gives full details of these, including electrically driven compressors. Particulars of one of these will be found on page 303, Manufacturer's Section, of this issue.

Lighting and Heating.

Illuminated Signs. The British Electric Signs Co., Ltd., 5 York Buildings, Adelphi, W.C., have sent us several descriptive leaflets on their system of illuminated signs. A detailed account, with illustrations, will be found in the Lighting and Heating section, page 274.

SMITHSON, SHARPE & CO., Sykes St., Hulme, Manchester, are makers of arc lamps and accessories, full particulars of which are given in two leaflets issued by the firm. A single enclosure arc lamp is also one of their specialities.

Lamps. THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby. A six page leaflet has reached us from this firm, describing their B.T.H. Edison incandescent lamps. Full particulars of the efficiency of the lamps and of the special sizes made are included in the list.

Accessories. THE GENERAL ELECTRIC CO., 71 Queen Victoria St., E.C., in their leaflet "Electrical Progress" for February, describe Peel Main Switches (reduced price), "Adelphi" D.C. motor switch, H.V. cut-outs, square cord grip, "Extra Sec" battery, new glass ware, and illuminating devices.

W. F. JONES & CO., 50 Cannon St., E.C., give full particulars of their "I" and "II" main switches in list B. This also contains prices of switches and details of fuses. The quick break enclosed switches of the same firm are described on a separate leaflet, while yet another particularizes the safety system of mounting and dismounting of fuses recently introduced.

W. H. HÖFLER, 26A Soho Square, W. An artistic booklet emanates from the office of this house, and a feature of the publication is a wallet inside the cover, into which the price-list can be slipped. The general items of interest to electrical engineers are ornamental fittings, chandeliers, lanterns, and tiles for the floors of central stations, sub-stations. The consulting engineer and tramway manager will be interested in a patent asphalted sheet lead damp course for protecting arches, culverts, and foundations. It is made in four grades, with special thicknesses of lead foil. A copy of this valuable catalogue can be obtained on application to the above address

Telegraphy and Telephony.

Fire Alarms. THE GENERAL ELECTRIC CO., LTD., 71 Queen Victoria St., E.C., are introducing a line of fire alarms known as the "Geeko." Among these is an automatic thermostat, which comes into action on excessive rise of temperature. This, together with fire alarm contacts, bells, indicators, and batteries, are priced and described in a leaflet.

THE ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., Stellite Works, Cheston Road, Aston, Birmingham, in a booklet "Central Battery Telephone Systems," give some interesting details of their small exchanges and their adjuncts thereto. The system is intended for large business houses, works, hospitals, etc., and one operator can, by the method employed, deal with 200 lines, or a smaller number if the cells are recorded. The boards are very compact, and from the details given should prove extremely valuable under the conditions mentioned. The booklet is artistically illustrated and contains full particulars and prices of the apparatus with which it deals.

Central Station Practice.

Transformers. THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby. Pamphlet No. 164 (superceding No. 94), deals with Type H Transformers of this firm. These are of the oil insulated type, but their construction will admit of a 10,000 volt test being applied to a dry transformer without injury. Full particulars of core windings and insulation are given by excellent sectional illustrations.

Valves. HOLDEN & BROOKE, LTD., Sirius Works, West Gorton, Manchester. A speciality in valves has recently been introduced by this firm. It is known as Green's Valve, and comprises a unique system in which two valves are employed, each actuated independently or by the same movement. We shall describe this valve in our next issue.

Oil Engines. R. CUNDALL & SONS, LTD., Airedale Iron Works, Shipley. This time honoured firm have handed us a copy of their oil engine catalogue, which has been neatly bound up in green and black. The chief points of the engine are touched upon and standard sizes tabulated, the remainder of the list containing testimonials as to the excellence of the engine under working conditions. This firm have also enclosed a copy of their folding machine catalogue.

Boiler House Plant. THE STIRLING BOILER CO., LTD., 2 St. Andrew Square, Edinburgh. We have had much pleasure in including in our list of catalogues a worthy addition in the shape of an artistic booklet issued by the above firm. The type and illustrations are of the highest class, and full advantage has been taken of modern printing methods to describe the productions of the firm. Typical installations are described in detail, while some excellent views of the works are included. The list of representative users of Stirling boilers in electricity works includes some fourteen large stations, and the horse power of the boilers installed totals 48,970, the largest users being the London County Council tramways, with sixteen boilers, aggregating 10,000 h.p. The same firm have sent us their list of marine boilers, which is equally well prepared.

Engine Packing. S. A. WARD & CO., Broad Street Lane, Park, Sheffield. Two two-page leaflets describing the "A.A.I." Floating Metallic Packing, and the Triplex Piston Rings manufactured by this firm.

Forthcoming Events

A complete list of the meetings of various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, will be listed under order of date in this section.

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

April 30th to December 1st, 1904.

Bradford Industrial Exhibition.

May 4th, 1904.

Electrical Exhibition, Warsaw.

May to September, 1904.

Colliery Exhibition, Royal Agricultural Hall, London.

June 25th to July 2nd, 1904.

Third International Congress of Mathematicians, Heidelberg.

August 8th to 13th, 1904.

Industrial Exhibition, Cape Town.

November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

THE date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St Louis Exhibition. The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

Papers before Societies.

Safety Devices for Electric Traction.

T. W. Sheffield, Manchester Inst. E.E. *March 29th, 1904.*

Direct Current Controllers.

H. N. Dutton, Manchester Inst. E.E. *April 8th, 1904.*

Glasgow Local Section, Inst. E.E.

Meeting. *April 12th, 1904.*

Modern Telephony.

A. B. Bennett, Glasgow Inst. E.E. *April 12th, 1904.*

Dublin Local Section, Inst. E.E.

Meeting. *April 14th, 1904.*

Institution of Electrical Engineers.

Meeting. *April 14th, 1904.*

Meetings, Conventions, etc.

American Electro-Chemical Society, Washington.

April 7th, 8th, 9th, 1904.

National Electric Light Association.

27th Annual Convention, Boston. *May, 1904.*

Books.

Radio-Activity, by Fredk. Soddy, M.A.

Dynamo, Motor and Switchboard Circuits.

Crosby Lockwood & Son.

Exhibition at the Agricultural Hall.

OUR readers will be interested to know that the Motor-Car Exhibition, now open at the Agricultural Hall, London, will be fully representative so far as motor vehicles for public utility are concerned.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

No. 4. Vol. I. London. April 26, 1904.

THE PROBLEM OF ELECTRIC RAILWAYS.

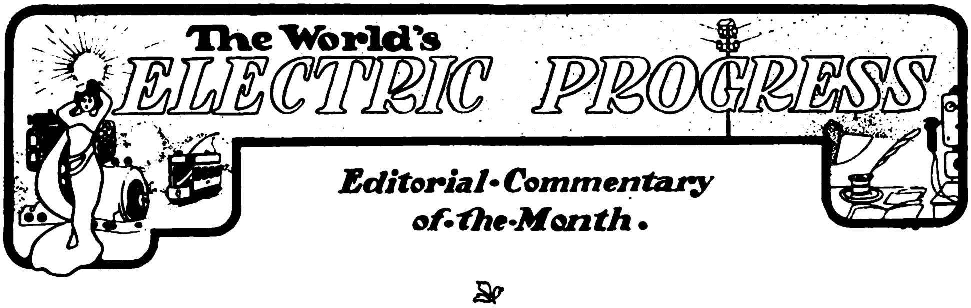
Since Mr. W. E. Langdon gave his views on the Electrification of main railway lines in 1901, and Messrs. Mordey & Jenkin advocated one phase methods in 1902, many marked changes have taken place in the attitude of both electrical and railway engineers towards the problem. Electrical engineers have modified their original designs considerably, and are now well on the road to that simplicity, which alone can command the attention and respect of railway companies. When the problem was seriously entertained of applying power to trains travelling over long distances, precedent could suggest no method for the application of that power. Proposals were limited to the employment of direct currents for the train motors, and as a result, combinations of high and low pressure systems were suggested, with moving machinery in sub-stations fringing the line. These early dreams of solving a great problem were naturally doomed to disappointment, experience prompting and subsequently necessitating an evolutionary course, as the more conducive to permanent progress and ultimate triumph. That this course has been productive of real advance towards the goal, none acquainted with the facts can deny, while it is equally indisputable that, at no distant date, a satisfactory system will be commercially launched, as the embodiment of many years' arduous and systematic experiment. The chief characteristic changes in the electrical aspect of the situation, lie in the advocacy of one phase motors and the employment of a high pressure line from which current can be utilised direct, without the intervention of either stationary or rotary transformers. Those of our readers who are following Mr. Mordey's argument and descriptions, will realise that the proposals at present made public, are, apart from their experimental nature, practical efforts at solving the problem, and are, further, material advances on anything yet done in either direct or polyphase work. The experiments at Zossen were chiefly valuable in demonstrating that high speeds were possible over slightly modified metals, while they also overcame any difficulties previously anticipated, or encountered in collecting high voltage currents at excessive speeds. It is, however, to the one phase motor and its development, that electrical railway engineers are now turning, and although finality cannot be expected from this quarter, the day of conversion from steam will have been brought within sight by this method. The experiments of Lamme, Arnold, the A. E. G., and the Oerlikon Co.—all external to this country, we regretfully record—will be awaited with considerable interest, not only by the electrical industry, but, we venture to think, by steam railway-men also. Everything points to the publication of some remarkable results, and we anticipate that railway companies, though confident of improved service with accelerated steam trains, will gradually admit the superiority of electrical operation, and welcome some simple system which will be both practical and comparatively inexpensive.

This brings us to the point from which to consider the attitude of the steam railway companies. The complacent disregard which steam engineers once entertained for electric trams has given place to a genuine respect for their rival, and we even have to record, that the competition of the lighter vehicle is being keenly felt, and that it has been found expedient to take a leaf out of the newer book, and apply electric power for the propulsion of inter-urban trains. While concessions of this character have been made,and will doubtless continue to be in typical instances, railway managers are still confident of maintaining their existing schedule times by steam drawn trains for a considerable period yet. This seems quite reasonable, and in examining the causes for such an attitude, we can only turn again to the proposals of electrical engineers. While in no way deprecating their work, we cannot, in justice to the industry, overlook a factor which is doubtless prominent in the minds of steam engineers; the fact that in comparing existing steam and electric railways, the former is the embodiment of simplicity and is self contained, while the latter, though not unduly complicated, is dependent on outside sources of power. We do not suggest that this latter feature is any disadvantage, but it represents so distinct a contrast to a system with locomotive units that the consequences of break-down at a power house or houses are apt to be unduly exaggerated, and schemes based on such means of supply condemned in consequence.

This of course is a mistake, as many thousands of miles of electric tramways give reliable service in this manner. Moreover, the principle has become recognised and proper precautions taken in its development, to ensure continuous supply under every possible exigency which may arise. When all is considered there is much wisdom in hesitating to adopt, over thousands of miles of line, a system which will have to stand the work of years and cannot be lightly thrown aside. That system may involve the maintenance of what are to the present steam railways, unnecessary externals, whose influence on the operation of the line will be of vital consequence, and whose failure may dislocate a now vital organ of commerce and state.

While we pleasurably record the work of electrical engineers in solving the greatest of all problems to which they have been committed, we cannot overlook difficulties which no delightful combination of electrical devices assembled on a train can possibly conceal, and which no elaboration of transmission schemes supplying power outside the trains can surmount. The secret of reliable railway organisation and operation lies in simplicity, and methods compelling maintenance of apparatus in out-of-the-way places cannot justly be said to conduce to that simplicity now so evident in steam lines. Although we point to what seem to us drawbacks from the steam engineers' point of view, to electrically operated trains supplied with power external to the line, we do not think that these are insuperable. They would need to receive serious consideration by the proper authorities before any change was decided upon, and might possibly form factors in arguments favouring caution, or it may be delay, in taking any steps. Should such objections lie at the root of the attitude of railway engineers, electrical men will doubtless prove equal to the occasion and furnish a reliable battery, the use of which, in conjunction perhaps with a supply service *en route* would dispense with high pressure conductors and a train service dependent solely on the power house. Until then, the steam engineer has no choice but the overhead wire, the efficiency of which on wide areas of tramways is at present recognised. That an equal degree of efficiency would be possible on a railway system there seems no reason to doubt, though the steam engineer must decide whether it shall become standardised throughout his particular system.

It will be interesting to note what the railway companies ultimately decide upon. Circumstances point to the acceptance of one principle, and time only can show what that will be. Of one thing we are assured that the method proposed will be a credit to electrical engineers, and well worthy of the efforts bestowed by them on a problem which shall perpetuate the value of electricity for traction purposes.



The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

❧

This section consists of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They are mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

Our Insurance Scheme.

IN addition to the advantages secured by annual subscribers to this magazine, and which have been set forth in detail in previous numbers, we are announcing this month, among the last pages of the tinted supplement, particulars of an insurance privilege we are prepared to extend to our annual subscribers. This carries a special guarantee of £500 at Death, £250 for permanent Total Disablement, and £1 10s. per week for temporary Total Disablement (10 weeks) from accidents while travelling, as described elsewhere. We have prepared this offer in conjunction with one of the largest Insurance Corporations, and are convinced that the benefits to be derived from the same will be recognised by every reader of the magazine.

Cheap Local Telegrams.

A LETTER addressed to Lord Stanley, by Dr. Reid Rentoul, urging the adoption of threepenny telegrams within a radius of one mile, has received the reply that it is impossible, for financial reasons, to adopt a lower rate than sixpence, at which, moreover, there is a loss already incurred. We cannot deny that the latter figure is wonderfully low, considering all the work involved in dealing with a telegram, and it is not probable that we shall be able to lower the cost in England. Other countries, where labour is cheaper, have gone to lower figures. For instance, Denmark, within the limits of the islands, charges a minimum of 37½ centimes, and in Ceylon a telegram can be sent to any part of the island for 4d.

Power House Architecture.

THE tone of the discussion on Mr. Stanley Peach's monumental papers—the printed copies are more than equal to many standard works in bulk—shows where engineers seek assistance from architects. The Institute of British Architects was invited to pay attention to the architectural features of power stations; the engineers present brought the discussion round to the subject of vibration, and how it might be prevented from interfering with the comfort of neighbours. The most useful hint given was dropped by Dr. Kennedy, who approved of foundations having a broad base and tapering as they rise upwards. If these are set upon a shingle bed and isolated from the surrounding subsoil and walls, we believe that much of the trouble will be eliminated. How often the foundations are merely excavated pits filled with concrete, and constructed in a manner most likely to transmit tremors to the surrounding earth. But, as Mr. Peach stated, the true central station is the bulk power house, which gives a wide berth to residences and premises which would be injuriously affected by earth or air vibrations, and as the present small generating centres become sub-stations less will be heard of vibration difficulties.

Cable Telegraphy.

It is apparent, when the vast extent of submarine cables is considered, that any enhancement of the speed of transmission would be of immense value. Such a possibility is prophesied in regard to the electro-capillary receiver of Armstrong and Orling. It is said that it has been already tested on one of the Atlantic Cables, and proved capable of recording, under good conditions, 80 words per minute. As compared with the syphon recorder, the adjustment is claimed to be less exacting. We welcome this promising invention, but cannot help thinking that there are difficulties yet to be overcome before such a rate of transmission as that referred to above can be maintained through a long cable.

⁂

Single Phase Electric Railways.

This subject, which is being ably treated in Mr. Mordey's interesting series of articles, is at the present time receiving more attention from engineers than any other branch of Electric Railway work. This is more especially the case in the United States, and Mr. W. A. Blanck's able and impartial review of the whole subject in a paper read at the Cincinnati Meeting of the American Institute of Electrical Engineers should be of the greatest assistance to all engineers who are interested in this very promising line of Electric progress. After outlining the principal systems which have hitherto been tried, the author considers in detail a typical 60-mile interurban railway equipped alternatively on the standard continuous current system with alternate current generators supplying rotary-converter sub-stations, and the alternate current system with static-transformer sub-stations and 3,000 volts supplied to the trolley line. Comparing, item by item, the capital costs of installing the alternative systems, he arrives at the conclusion that the continuous current system will cost 32 % more than a single phase system giving the same service.

⁂

New Radio-Active, Self-Luminous Elements.

The most remarkable discovery ever made by an American chemist is that recently announced by Dr. Baskerville, a professor at the University of North Carolina. By distilling thorium oxide in a quartz tube with carbon and chlorine he has obtained two new elements, termed by him berzilium and carolinium. The former appeared in the form of a greenish gas, which was condensed to a powder of similar hue; and the latter was produced in the form of crystals adhering to the quartz. As the result of his experiments, Dr. Baskerville has obtained 5 grammes of berzilium and 2½ grammes of carolinium, and it is stated that the properties of these are so powerful that they exhibit a distinct glow through enclosing tubes of copper, brass, india rubber and iron, all covered with cloth. These new elements will probably possess commercial value in application to illumination and may possibly lead to some new departure in gas lighting. The vapour of berzilium has already been observed by Berzilius, who, however, took no steps to condense it or to examine its properties. This discovery is interesting as adding two new elements to the list of those already known, but its importance lies chiefly in the fact that it gives the world two new radio-active, self-luminous substances.

⁂

The Mosely Commission.

The issue of its reports by the Mosely Educational Commission to the United States—a volume of 400 pages—is typical of the zeal of that enterprising body. The entire volume is of value to electrical engineers, but their chief interest will centre in the report of Prof. W. E. Ayrton, who deals with the education of the American electrical engineer. We may also refer to the report of Prof. Magnus Maclean on the development of the American educational system, as containing much useful data. Prof. Ayrton considers American methods in advance of those of Great Britain chiefly by reason of the bond of union between colleges and works. While an engineering apprentice is preferably a college trained man, an engineering professor in a college should also be actively engaged in the practice of his profession. Prof. Ayrton regards the American student as less scholarly than his British *confrère*, yet he has his knowledge in a better form to apply. The British system produces a man of knowledge and principles; the American product is a business man with a scientific training. The work of the Mosely Commission should bear much fruit in this country and though we are not prone to slavishly copy the methods of our neighbours, we can still profit by an interchange of ideas such as has been possible with the body under consideration.

Standard Screw Threads.

For some time past, the Engineering Standards Committee have been considering the question of screw threads, and to the information collected in the ordinary way will be added that afforded by the conference to be held on the 19th and 20th of April, at the Institution of Civil Engineers. The point of chief interest is to be found in the question as to whether the present Whitworth and B.A. screw threads are sufficient for all practical purposes. We do not gather that there has even been any intention of departing from the Whitworth standard, as one of our contemporaries seems to think. The question is simply whether the Whitworth and gas threads afford sufficient variety for the requirements of the present day. In former days engineering practice was comparatively limited in scope, and as we now have to consider the convenience and the practice of those engaged in electrical engineering, motor car and cycle manufacture, and other branches of industry, it is in every way desirable that the standardisation of the various screw threads used should be undertaken. The use of the two existing standards is fairly universal in ordinary work, and we trust that the effect of the recent conference will be to introduce uniformity into the practice of those who at present find it necessary to employ special threads for which no recognised standards are in existence.

The London Traffic Problem.

From week to week reports appear of the proceedings of the Royal Commission appointed last year to investigate the general question of traffic facilities in London. There can be no question that a mass of useful information is being accumulated, and that valuable expressions of opinion are being elucidated. It must be admitted, too, that in conducting an inquiry ranging over so wide a field, it is impossible to entirely prevent the introduction of useless and irrevalent matter. It is, however, very widely felt, among those interested in the proceedings, that the ratio of chaff to wheat might be very considerably reduced without any appreciable loss of good grain, and that the irresponsible faddist has been far to much in evidence. Some of the schemes put forward, which might be well worth serious consideration if there were no existing means of inter-communication, are ruled out of court by what would appear to be the perfectly obvious necessity that any scheme, to be feasible, must consist of a continuation and extension of existing lines of communication. One point being brought out very strongly is the necessity for a central authority having full powers of dealing with the question of railway and street traffic within the Metropolitan area. A second point is that the London County Council has been shown to be thoroughly unfit to be largely represented on the body constituting such an authority; and a third point of fundamental importance is that considerable legislative changes are absolutely imperative as a preliminary to effective action on the part of the Central Authority.

Telephone Extension between England & France.

We are pleased to observe that during the last few days a considerable extension has been made of the facilities for inter-telephonic communication between this country and France. Subscribers to the Central, Western, Victoria, Putney, and Mayfair exchanges of the Post Office in London are now able to communicate with Amiens, Armentières, Bethune, Bordeaux, Boulogne, Caen, Calais, Cambrai, Chârtres, Denain, Dieppe, Dijon, Douav, Dunkirk, Elbeuf, Havre, Lens, Lille, Lyons, Marseilles, Nancy, Orleans, Paris and suburbs, Roubaix, Rouen, St. Etienne, St. Quentin, Tourcoing, Tours, and Valenciennes. Communication is now also available between the post offices at Birmingham, Bradford, Brighton, Bristol, Cambridge, Cardiff, Derby, Hull, Ipswich, Leeds, Leicester, Liverpool, Lowestoft, Manchester, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton, and Yarmouth, and renters of wires into those offices on the one hand, and Paris and certain of the above-named French towns on the other. Particulars of the service may be obtained from the local postmasters or from the secretary, General Post Office, E.C. The general charge for conversations exchanged with French towns is 8s. for three minutes, with the exception of Bordeaux, Marseilles, and St. Etienne, for which the charge is 10s. for three minutes. The service now arranged constitutes a most remarkable example of the great improvements made during recent years in telephone apparatus, and we trust it will prove to be one more link uniting two great nations in the bonds of amity.

* * *

The Metric System.

Ordinary men have little ambition to control the destinies of the world from the grave. The late Herbert Spencer was evidently not one of these, for in the pamphlet recently published in accordance with the provisions of his will, we find a determined, if futile, attack on the Metric System. The opposition therein expressed is chiefly of academic character and has little practical importance. We all know that the metre in itself does not precisely represent the ten-millionth part of the quadrant of the earth's meridian, but that makes no difference whatever to business men. Again, it is no argument against the system, as the author seems to think, that 0·01 metre is described as one centimetre, or 1,000 kilos as one tonne. A disadvantage is certainly to be found in the impossibility of dividing ten into three equal parts, but that and all other drawbacks are more than counterbalanced by the simplification of calculations generally. No doubt the compulsory change of all existing British weights and measures would involve an enormous amount of trouble, but the change need not be suddenly effected. Bearing in mind the universality of the metric system on the Continent, and in other parts of the world, it is abundantly evident that the greatest possible advantage to the British export trade and especially to those concerned in the export of electrical machinery and apparatus, would result from the synchronisation of our methods of measurement with those generally adopted by our foreign competitors.

Unnecessary Risks.

In every department of work, men seem to take a delight in exposing themselves to needless dangers and risks. Sometimes there is a foolish ambition to "show off" before others, and at others nothing but the contempt engendered by familiarity with danger. The steeple-jack performs unnecessary antics at a dizzy elevation, the bridge erecter works unconcernedly on a 3-inch angle-bar a hundred feet above the ground, and the coal miner opens his safety lamp simply to obtain a light for his pipe. The men employed in an electricity station have little or no inducement to give gratuitous displays of foolhardiness, but they often disregard precautions intended for their safety. The latest instance of such omission is afforded by the fatal accident to a switchboard attendant at the generating station of the Charing Cross and City Electric Light Company. In this case, however, the attendant circumstances were so unusual that it is not altogether surprising to find that precautions were thought unnecessary. The sub-station motor generators were disconnected, the main engines were slowed down, the generator fields broken, and the main switches opened. The voltmeter standing at zero, the attendant was instructed to remove the cable fuses from a particular section of the switchboard. As all the fuses were apparently dead, the unfortunate man thought it unnecessary to use the insulated tongs provided by the company, with the result that, while he was removing the seventh fuse, he received a fatal shock from what must have been a static charge retained by the cables after the engine had slowed down. Similar shocks are not altogether unknown, and however remote the possibility of danger may appear to be, central station employées should never neglect any precaution dictated by prudence or ordered by the management. The apparatus they are about to handle may be thought to be dead, but there is always a possibility of danger, however unexpected or unusual it may be, as this unhappy man found to his cost.

* * *

Pig Iron and Electric Power.

The official figures relating to the production of pig iron in the United Kingdom during the year 1903 have been published by *The Iron and Coal Trades Review*, and will be interesting in view of Mr. Allen's article on Mining and Metallurgy. From the following figures Great Britain is lowest of the three principal iron producing countries, this being the first time that the output of Germany has exceeded that of Great Britain.

Output of Pig Iron for the year 1903.

United States	18,297,400 tons.
Germany	10,085,634 „
Great Britain...	8,811,204 „

This in itself is food for reflection. From figures kindly furnished by Mr. John H. Darby, of Brymbo, who gave evidence before the coal commission last year, it would appear that the present annual production of metallurgical coke in the United Kingdom is about 10,500,000 tons. This is, of course, exclusive of gas coke, and well agrees with what would be wanted for blast furnace requirements, foundry purposes, steel melting, malting, etc. However, the point is that this 8,811,204 tons per annum equal 24,140 tons per day of pig iron. Both Thwaite in this country and most of the German authorities agree closely in the estimate that, used in efficient gas engines, 35 h.p. are available per 24 hours for every ton of iron produced during the day, after deducting the gas required for heating the hot blast stoves and allowing for the power required to drive the blowing engine. The other little items making up what the French call "the service of the furnace" would also be included. These figures are fairly correct, but in a recent estimate by Karl Gruber (*Stahl und Eisen*, Jan. 1st and 15th, 1904) the amount of surplus power is placed at a lower figure, 23.7 h.p. per ton of iron, but this is probably unduly low, and it is not quite clear from the paper as to how far the gas has to be employed for raising steam. However, to be on the safe side, and take only 30 h.p. per ton, this would give 24,140 × 30 = 724,200 h.p. available after the blast furnace has been made self sustaining. Assuming that 1 h.p. thus produced was worth only £2 per annum, this would be worth £1,448,400. No doubt the bulk of this power could be most profitably employed in the steel works and rolling mills, but still its equivalent, if produced from some other source, would have to be paid for, and any surplus power sold would, of course, realise much more than £2 per h.p. per year.

The idea that good metallurgical coke cannot be made in recovery coke ovens is now regarded as erroneous, and if the annual yield of 10,500,000 tons of coke was produced in closed recovery ovens, as it should be, not only would a number of bye products of great monetary value be obtained, but a further source of power equal to 115,068 h.p. would be available, this being reckoned on a daily make of 28,767 tons of coke multiplied by 4 h.p. These figures speak for themselves, and when their significance is fully realised, the builders of large dynamos and gas engines ought to be kept busy in this direction for some years to come.

Lessons from America on Technical Training.

Of the many aspects of the problem of technical training there is one which demands the careful attention of both the professor and student of engineering, and that is the employment of technically trained men by the large engineering firms. The extent to which college men occupy the positions of industrial leaders in the United States must be very encouraging to the educational authorities in the States, and it is a very noteworthy fact that, for some considerable time, the industrial activities of our American cousins have been directed, with success, by college-bred men to a greater extent than in any other country of the world, with the possible exception of Germany. It is consequently not surprising that technical training is more appreciated in America than in Great Britain. As a proof of this we abstract the following information from Mr. Robert Blair's recent report presented as a member of the Mosely Education Commission to the Irish Department of Agriculture and Technical Instruction on "Some Features of American Education."

Mr. Blair found that in the Westinghouse shops and offices 160 college-bred men are engaged, out of a total of 10,000 employées. At the Carnegie Steel Works, where there are 7,000 hands, there were about 100 technically trained men, seven of the 23 leading officers being college graduates. Of 118 engineers on the staff of the Rapid Transit Railroad Commissioners of New York City, who are constructing a city underground railway, 84 per cent. had been college students; of 75 petty officers 58 per cent. were college trained. In the Baldwin Locomotive Works, 43; on the Pennsylvania railway lines west of Pittsburg 52 (nearly all being graduates); at the Schenectady works of the General Electric Company 264; the Illinois Central Railroad Company employ 200 men who are either graduates of a technical institution or have had some training in that line; the Baltimore and Ohio Railway have employed in their maintenance of way department since January, 1901, 59 graduates of technical schools and universities, of whom 49 remain; in the mechanical and electrical departments the same company have 24 graduates among their 559 apprentices.

The opinions of the industrial leaders as to the value of technically trained men are not less conclusive. They are agreed that the college graduate will go further than the school boy, and rise more rapidly, because he has more behind him—a longer training and a "safety and security of knowledge." When a college man has mastered the ordinary business practice, his superior intellectual training will soon tell in a readier grasp, broader view, and greater general capacity, and he will rapidly outstrip the other who started earlier but with a limited mental equipment. Mr. Blair emphasises an important lesson which we have, on the whole, yet to learn, *i.e.*, that those who hope to make the industry and commerce of the future must prolong their technical and college education by some years. It is somewhat surprising that, whilst this principle has been well recognised by the medical and legal student, it has almost entirely been discarded by the engineering student. Now that the demand for college men is so great we may turn to the qualities which the industrial leaders expect from the college men; we are told that they do not look for the first in studies, nor the first at sports, nor indeed for those who exhibit pre-eminence in any one direction, but rather the men of good all-round ability and of physique. Absence of certain social qualities would be a bar—not on grounds of class distinction, but of unfitness to be persuasive and tenacious amid opposition. The men must not be "too big for their boots," nor afraid of the grease and dirt of a factory, nor disposed to complain that their work and pay at initiation are beneath the dignity of a college man with such a high degree. The early stages of an industrial cadet's work are undoubtedly none too pleasant, considering the men and their previous experience, and the pay is small, but the prospects are great for those who persist. American firms are too shrewd to demand what is not necessary or not useful; and the colleges provide what is necessary and useful, because they have realised that they are professional schools, and must turn out industrial cadets as capable of entering into practice as are graduates of medicine and law. Mr. Blair is of the opinion that the British plan of training leaders is distinctly inferior to the American; indeed, he thinks we are not making the most of one of our most valuable national assets—the character and ability of our youth; and one of the most serious obstacles is the method of paying high officers.

German Technical Education: A Note for Students.

THE high degree of excellence attained in the great technical universities of Germany is well known in this country, but insufficient attention has been paid to the admirable courses of secondary technical education provided by technical schools in different states, for the benefit of those engaged in various industries and occupations. There are no less than twelve of such institutions specially devoted to separate branches of the metal industries, and of these the technical school at Aue, in Saxony, is particularly worthy of the notice of our readers. This school was founded as far back as 1877, by an association of persons connected with the plate and sheet branches of the metal industry, but it now provides an excellent course of education in electrical work. Since its foundation the school has been attended by more than 1,000 pupils, not only from Germany, but from all parts of Europe. The principal object of the institution is combined theoretical and practical training, in as short a space of time as is consistent with thoroughness, special attention being also directed to the commercial and artistic aspects of the instruction. The instruction given at the school consists of a general course lasting three terms of one half-year each, and of several other special courses of a shorter duration for certain branches of work. The instruction given in the general course is theoretical and practical; the theoretical subjects for the three terms including arithmetic, algebra, geometry, stereometry, physics, mechanics, chemistry, technology, electro-technics, building-construction, ventilation, drawing (including sketching, freehand, projection building, and metal-work, drawing and shading), modelling, correspondence, book-keeping and the elements of law.

The practical classes include instruction in many departments of work, among which may be mentioned (1) the use of tools and the construction of sheet-metal working machines, (2) making various articles of sheet iron, tin plate, zinc, copper, brass, German silver, nickeline and aluminium-bronze, (3) lacquering and bronzing metal goods, (4) gas engine construction, (5) gasfitting and plumbing, (6) electro-metallurgical work, and (7) electric installation work. The courses in electric installation work are particularly complete and include electric bells, house telegraphy, telephones, lightning conductors, and electric light installations of different systems fitted up in the installation and other rooms of the school. Each half-year the pupils, engaged in carrying out installations, are practically instructed in the most important details, such as the connection of cells, the regulation of current, and the measurement of resistance by various bridge methods, telegraph and telephone lines, the taking up of old and the laying of new lines, the design of systems of connection, the jointing and branching of wires, the insulation of joints the leading of the wires through walls by means of insulating tubes, securing wires to insulators, fitting up batteries, keys, bells, indicators, fitting up lightning conductors, laying earth plates, testing and making earth connections, measurement of the resistance of overhead lines and of earths, and the detection of faults. In the model electric light plant provided, the pupils are not only made familiar with the use and management of the dynamo, the accumulator and other apparatus, but in each half-year one or more new circuits are run, so that the pupils shall obtain a thorough insight into practical installation work. The instruction given is assisted and supplemented by drawings, models, technological collections, physical apparatus, a library of technical works, the best machines and tools and appliances for gas, water, and electrical installations. The school is situated in the midst of a manufacturing district and frequent excursions are made to these works in order to make the pupils acquainted with the practical processes in use.

The fees charged are extremely moderate, and, in accordance with the general practice at German secondary technical schools, indigent and industrious pupils are partially or wholly dispensed from fees. Moreover, deserving and poor pupils who have been at least one term at the school are actually boarded and lodged free of charge. We could cite other institutions where the educational advantages are equally liberal, but the school at Aue is a sufficient illustration of the splendid facilities provided in Germany for the thorough instruction of craftsmen in electro-technical work.

"The Electrical Magazine" offers its annual subscribers, in addition to unique advantages, a compendium of information, in concise, artistic form, on the chief events in electrical circles during the preceding month. The enthusiastic reception with which it has been received is a guarantee of its merit, its influential staff of contributors typifies the high standard of its contents, and the privileges conferred upon its subscribers testify to the generous manner in which the directorate is prepared to deal with their supporters. It is, to say the least, unwise to continue any longer *outside* the list of subscribers.

THE ST. LOUIS UNIVERSAL EXPOSITION, 1904.

IN presenting our readers thus early with a few details of this, the world's greatest and grandest exhibition, we feel we cannot do better in the initial paragraph than quote the words of the late President McKinley uttered by Mr. F. J. V. Skiff, Director of Exhibits, on the occasion of the banquet to the Commercial Clubs of Chicago and Cincinnati when these large bodies visited the Exposition:

"'The wisdom of all ages is none too great for the world's work.' In this single salient sentence, uttered in his famous address, at Buffalo, in September, 1901, President McKinley described the object and the result of expositions—particularly of international, universal expositions.

"A modern universal exposition is a collection of the wisdom and achievements of the world, for the inspection of the world—for the study of its experts, by which they may make comparisons and deductions, and develop plans for future improvements and progress. Such a universal exposition might well be called an encyclopædia of society, and it will contain, in highly specialised array, society's words and works. It constitutes a classified, compact, indexed compendium (available for ready reference) of the achievements and ideas of society, in all phases of its activity, extending to the most material as well as the most refined. It offers illustrations covering the full field of social performance, from the production of the shoes on our feet and the pavement beneath them to a presentation of the rarest and most delicate creations of the brains and hands of men in what are classified as the fine arts of civilisation.

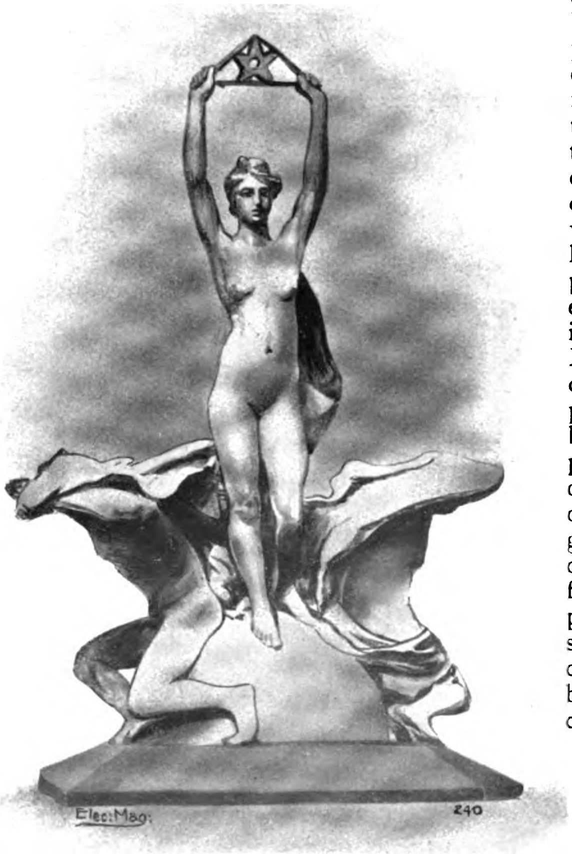
"The creators of the St. Louis Exposition have had the experience of all previous great expositions by which to plan and effect its high organisation. The continuous and repeated burden of the message of experience handed down by all expositions has been more perfect, more effective classification and arrangement of exhibits. Each exposition has left this present for its successor, and the advice has come down in increasing emphasis and with increasing significance to the present, with the result that it is now to be commensurately heeded. In the St. Louis Exposition everything is to make way for the most thorough and direct presentation of its assembled treasures.

"The highest state of preparation and classification in expositions is absolutely required in order to render them practically available by the investigator. A visitor, to get value of an exposition, must have the objects of his study so grouped and presented that he may apply himself directly to the examination of them without having to mentally assemble them, himself, from different parts of the exposition, and without having scattered about them objects of a miscellaneous nature, which divert and distract the attention instead of furnishing necessary comparisons and resultant information on his subject. The classification of an exposition, therefore—the method of the disposition and presentation of its exhibits is one of its vital features, regulates, in fact, the degree of its effectiveness and success—records its value to the public and to society.

"The St. Louis classification is divided into 16 departments, 144 groups, and 807 classes. These grand departments in their order will record what man has accomplished at this time with his faculties, industry, and skill, and the natural resources at his command in the environment in which he has been placed.

"At the head of the Exposition classification has been placed Education, through which man enters social life. Second, comes Art, showing the condition of his culture and development. Liberal Arts and Applied Sciences are placed third, to indicate the result of his education and culture, illustrate his tastes and demonstrate his inventive genius, scientific attainment, and artistic expression. These three departments equip him for the battle and prepare him for the enjoyments of life. The raw material departments—Agriculture, Horticulture, Mining, and Forestry—show how man conserves the forces of nature to his uses. The Department of Manufactures will show what he has done with them; the Department of Machinery the tools he has used. The Department of Transportation will show how he overcomes distances and secures success to all parts of the world; the Department of Electricity will indicate the great forces he has discovered and utilised to convey power and intelligence. And so through the several departments to Anthropology, in which man studies man; and to Social Economy, which will illustrate the development of the human race, how it has overcome the difficulties of civilisation, and solved the great problems in which society is involved. Last is placed Physical Culture, in which man—his intelligence having reached the supreme point—is able to treat himself as an animal, realising that his intellectual and moral constitutions require a sound physical body to prompt them to the proper performance of their function.

"The occasion for a World's Fair—a presentation of the productiveness of mankind, at certain intervals of time, should not be ascribed to commonplace motives. It it not the act of individuals, nor of communities, nor of sections. It is rather the reflection of an educational revival or uprising influencing some great zone of civilisation; individuals and communities being but the agencies employed. It is part of the Great Plan. And just as the glacial flow left the external evidence of its tremendous momentum on the imperishable rocks, so these great expositions leave their everlasting impression and vast influence on the progress of the ages and the development of the human race. As I felt justified in saying at the Commercial Club at Chicago, broadly speaking, a universal exposition could be held on a prairie. The large city is important in just the degree that it can contribute to the comforts and convenience of visitors. But the locality of an exposition—a great exposition — is incidental. St. Louis is the locality of the Exposition of 1904, because at this particular point, on the firing line of Western progress, the forces of civilisation found their most potent expression and greatest climax. The benefits to the community are patent. The vicinity is given a wonderful education and culture, and gains a cosmopolitan habit that elevates its citizenship and broadens its social life. The results of the country are reflected in its increasing commerce, its improved international policies, and its higher and keener estimate of its relationship and responsibilities beyond its own domain. The yield to the world is in the



"LIGHT AND DARKNESS," PALACE OF ELECTRICITY.

universalising of things, in the realising of interdependence, in the growing 'brotherhood of man and fatherhood of God.'"

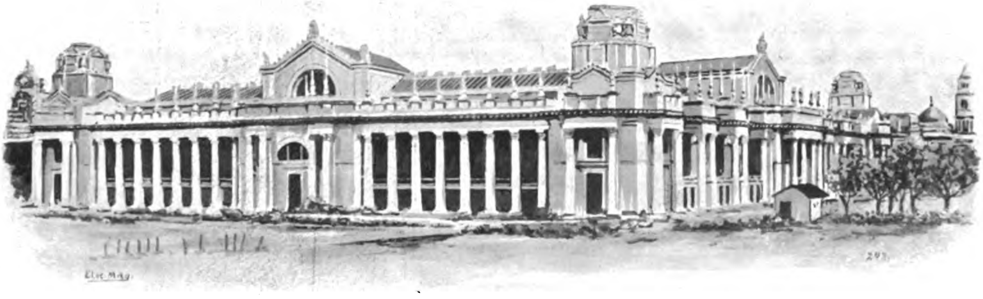
We are naturally chiefly interested in the electrical section of the exhibition, and though we shall go into considerable detail (later in the year) with the most prominent exhibits, we take this opportunity of familiarising our readers with the features of the electricity building. The beautiful examples of statuary we reproduce will doubtless be appreciated, and some idea be also given of the magnificent scale on which the entire scheme has been planned.

The electricity buildings—the location of which can be gathered from the plan on page 350—will contain exhibits of almost every class of electrical devices throughout the entire range of present types. Early forms of apparatus, through the agency of the American Institute, will be on view, and this collection, though of a temporary nature, will be one of the most interesting. From a number of pamphlets kindly supplied by the Royal Commission, we find that Prof. W. E. Goldsborough is responsible for the administration of the Palace of Electricity, and a contribution of his to one of these superb productions sums up the case so clearly that we reproduce it herewith:

"The largest classification, both in area of space and number of exhibits, will be that of the machines for generating and using electricity. Dynamos and motors of all the principal makes, both alternating and direct current, will be on exhibition, most of them running. The largest of these will be located under the travelling crane along the west side of the Palace of Electricity, to facilitate placing and removing heavy parts. Motor-generators, rotary converters, transformers, rheostats and regulators of every form will be so arranged and connected as to demonstrate their various functions. There will be shown ingenious applications of motors to the diverse forms of power machines, in which so much progress has been made in recent years. The principal companies in the electrical industry are mainly interested in this general classification, and their representation in the group will do credit to themselves and to the Exposition.

"Opportunity will be given both for still and live exhibits in the street railway field. Those within the Palace of Electricity will be chiefly motors, controllers, switch boards and auxiliary apparatus. Outside there will be a double testing track about 1,400 feet long, upon which speed, acceleration, braking and efficiency tests can be run. Electric railway equipments of standard form will be tested, and not only this, but systems now being developed will be given official recognition, and the utility of electric railway signal apparatus and safely devices of every form will be demonstrated.

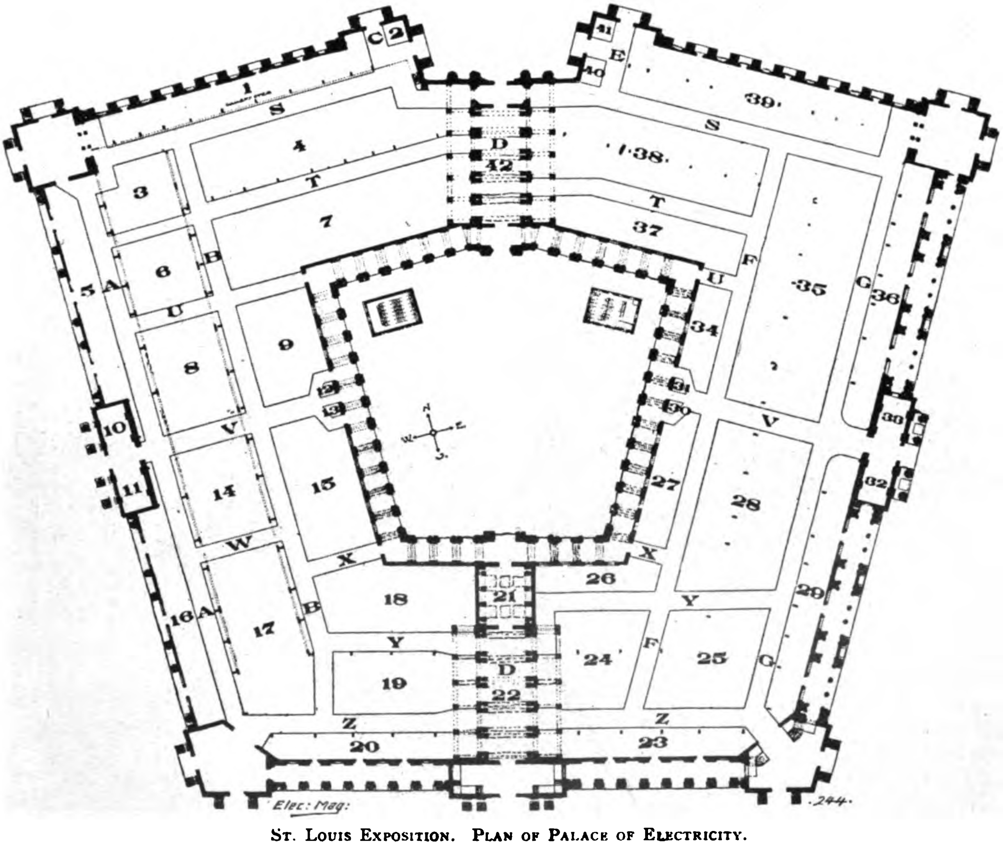
"Expositions both in this country and Europe have marked each great step in the advance of high potential practice, and St. Louis is to be no exception. Arrangements have been made and are in progress for showing the phenomena of high potential currents, beyond anything in this line attempted in previous Expositions. While proper safeguards will be thrown about



St. Louis Exposition. Palace of Electricity.

such demonstrations, yet it is intended to make them in such a way that the general public as well as electrical engineers may profit by them.

"Perhaps the wireless telegraph and telephone exhibits will attract as much attention as any other feature on the grounds. The largest wireless telegraph station ever erected will have a conspicuous location, from which visitors may send messages to adjoining cities in the same manner, and with the same expedition as they would send them over a telegraph line.

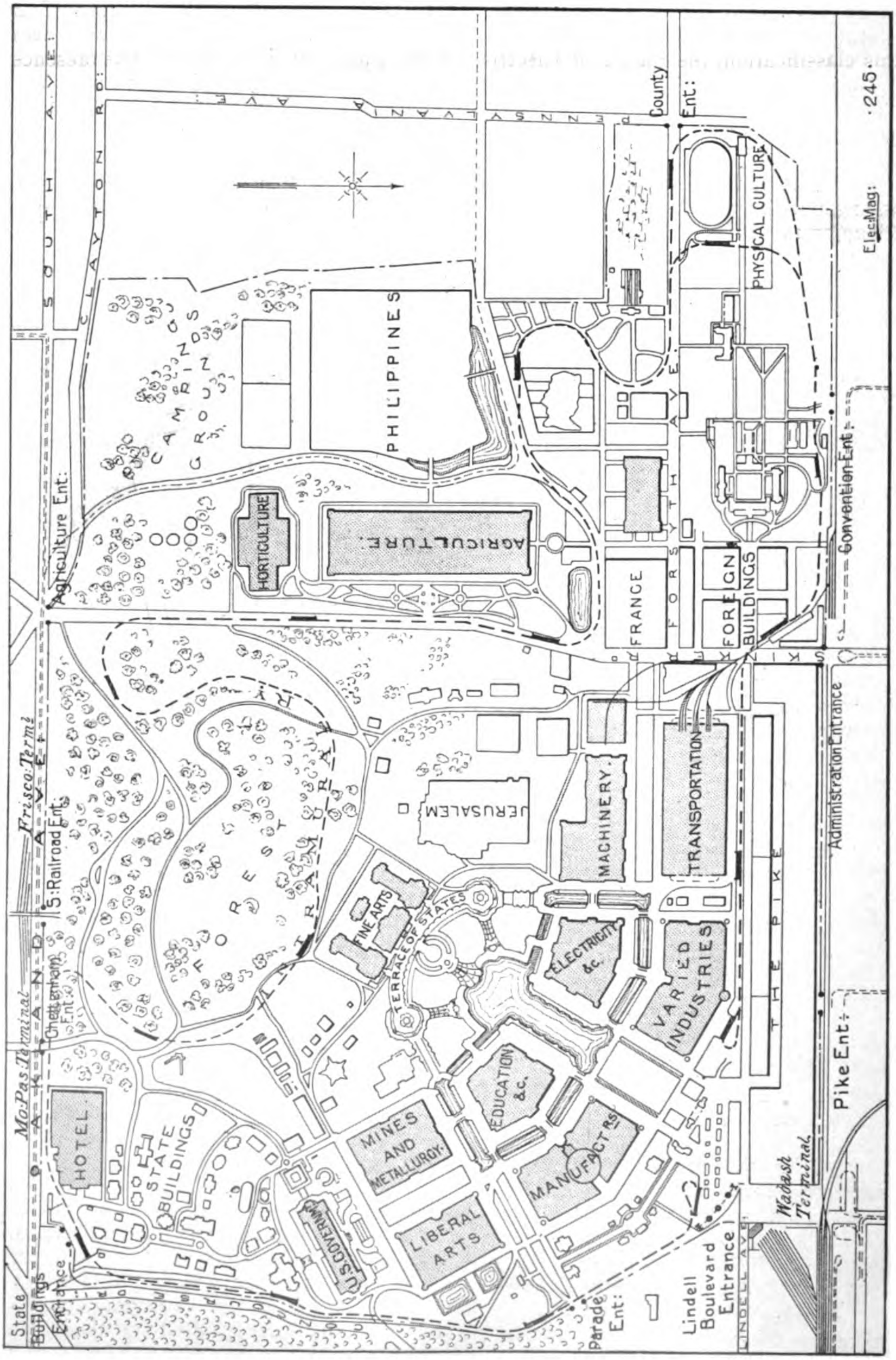


St. Louis Exposition. Plan of Palace of Electricity.

"Several inventors and companies have prepared plans for exhibits of wireless telephony over comparatively short distances. The telephone stations, separated the length of the building, will be used without any metallic connection between them. The waves will emanate from the coils of the sending station, and will induce corresponding pulsations in the coils of the receiving station, so that a conversation can be heard from one to the other.

"It is probable that no branch of therapeutics has made a greater advance than the electrical. Electricity in the form of direct, alternating and intermittent current is now utilised in the treatment of many forms of diseases, especially chronic cases which have been especially refractory. The electro-therapeutic apparatus will include x-ray tubes for physical treatment and for diagnosis, and the Finsen lights which give off actinic or higher light rays, and are especially efficacious in the treatment of certain diseases.

"Electro-magnetic instruments will also be on exhibit, and will be shown in operation for thespecial treatment of ear diseases. The acoustican, an instrument which very largely performs the function of the ear, will be graphically demonstrated, and persons who have never heard a sound since birth will receive the sense of hearing



St. Louis Exposition. Plan of Grounds and Exhibits.

through this instrument. On account of the great number and variety of exhibits in this classification, the Palace of Electricity will prove a centre of interest to the surgeons and physicians who are keeping abreast of the times in their particular work.

" A large number of inventions in electric lighting have been made in recent years, and these will all be demonstrated in a way which will be exceedingly attractive to the public. Arc lamps of every kind will be shown, and incandescent lights of every size and colour will be displayed. Nernst lamps will be utilised in lighting one of the buildings. The Cooper-Hewitt vapour arc lamps will illuminate the Cascades, and will be shown in the Palace of Electricity. These lamps emit an intense white light, in which the absence of red rays gives a very peculiar effect. Vacuum tube lighting by means of induced currents will also be shown in a way that will be exceedingly attractive to the eye.

" In the field of electro-chemistry many new processes have lately been developed into commercial possibilities. A number of the great manufacturing companies at Niagara Falls and other water power centres have decided to show their electric furnaces and chemical processes in operation. The products of these furnaces are, as a rule, much purer than the products which are made in any other way, and it will be of interest to the public to see the operation and the chemical changes which go on under the influence of the electric arc.

" Arrangements have been completed for the establishment of special laboratories in the Palace of Electricity, with complete sets of recording instruments, whereby the juries of award and exhibitors may conduct careful and accurate tests upon every kind of electrical apparatus which may be shown in the Palace of Electricity. The presence of such laboratories at an exposition is a new departure, and will add greatly to the value of the awards, as the personal factor and the personal judgment of the jury will be minimised because the actual data regarding the performance of the machines or mechanism can be accurately ascertained.

"Heat." Palace of Electricity.

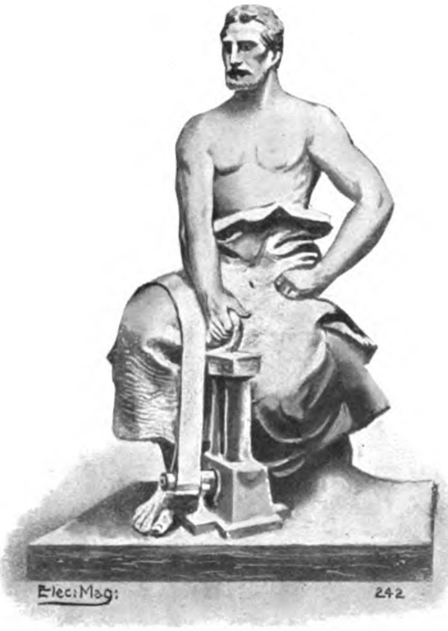
" A number of historical exhibits of very great merit are to be placed in this building. Thomas A. Edison, Chief Consulting Electrical Engineer of the Department, has planned a personal exhibit, showing the earliest forms of the incandescent lamp, phonograph, generators and other mechanisms which he has contributed so much to develop. The storage battery he has designed especially for automobile use, combining light weight with high discharge rates, will draw the attention of engineers as well as the public.

" Displays from several associations, universities and laboratories will contain delicate and accurate instruments, as well as indicate methods of research work. It is intended to have these exhibits which are not commercial in character to be highly educating to the public, and thus dispel to some extent the mystery which enshrouds the layman's mind in all things pertaining to this form of energy.

" Not only in a material way will the Electrical Department be a centre of interest, but the International Electrical Congress will draw from all countries the most eminent engineers. The Congress at Chicago in 1893, and at Paris in 1900, had an important influence on the world's progress in the knowledge and application of electricity and magnetism, and it is expected that the gathering this year will be equally potent. The date set of the International Electrical Congress of St. Louis is the week, 12th to 17th of September, 1904. Conventions of electrical associations will be held simultaneously in connection with the Congress, but each will have its separate programme and place of meeting, until the final day, when a general convocation will be called. The Exposition authorities will provide ample facilities for the accommodation of the Congress and the various conventions in the halls of the Washington University, and the other buildings about the grounds.

"Dr. A. E. Kennelly, Secretary of the International Electrical Congress, has lately announced the appointment, by President Elihu Thomson, of the officers for the various sections of the Congress. All of these gentlemen, who are well-known specialists, have accepted the appointments. The section officers will have charge of the proceedings of the Congress at St. Louis in their respective sections.

"The papers to be read at the Congress will be communicated by invitation from well-known authors in this country and abroad. They are to be read and discussed at St. Louis during the Congress week, September 12th to 17th, 1904, and afterwards printed and published in book form.



"Power." Palace of Electricity.

"Invitations to join the Congress are steadily being issued to persons and parties interested in electricity. Over 6,000 such circular letters of invitation will be sent out in the United States, and a similar number in foreign countries. Most of the circulars are being directed to members of electrical industries, societies, and scientific institutions. Joining the Congress will entitle the member to attend the various functions at St. Louis, and also to receive a copy of the subsequent transactions. It is expected that many will join the Congress who cannot expect to attend the sessions at St. Louis, merely to receive the subsequent printed transactions. The transactions are expected to form a very valuable addition to electrical literature, both theoretical and practical. Already about 800 Americans have joined the Congress in response to circulars, and only part of the circular catalogue has been covered. There is, consequently, every reason to expect a large and representative membership in the Congress, both from this country and abroad."

Officers for Various Sections of the International Electrical Congress.

	Section Subject.	*Chairman.*	*Secretary.*
A.	General Theory—Mathematical. Experimental.	Prof. E. L. Nichols. Cornell Univ.	Prof. H. T. Barnes, McGill Univ.
B.	General Application.	Dr. C. P. Steinmetz, Schenectady, N.Y.	Prof. S. Sheldor, Poly. Ins. Brooklyn.
C.	Electrochemistry.	Prof. M. S. Carhart, Univ. of Michigan.	Mr. C. Herring, Philadelphia.
D.	Electric Power.	Mr. C. F. Scott, Pittsburg.	Dr. Louis Bell, Boston.
E.	Electric Light.	Mr. J. W. Lieb, Jr., N.Y.	Mr. Gano S. Dunn, N.Y.
F.	Electric Transportation.	Dr. Louis Duncan, Mass. Inst. Tech.	Mr. A. R. Armstrong, Schenectady.
G.	Electric Communication.	Mr. F. W. Jones, N.Y.	Mr. B. Gherardi, Jr., N.Y.
H.	Electric Therapeutics.	Dr. W. J. Morton, N.Y.	Mr. W. J. Jenks, N.Y.

The articles under this section being of general interest to electrical men, are not classified under the ordinary sections of the magazine.

THE THEORY OF ALTERNATORS.—IV.

By ALFRED HAY, D.Sc., M.I.E.E., etc.

(Continued from page 239).

ANALYTICAL AND GRAPHICAL THEORY OF IDEAL ALTERNATOR.

THE relations connecting the P.D. with the open-circuit E.M.F. and current are easily obtained if r, R, and l, L are known. If v denote the P.D., then (see p. 131)

$$\begin{aligned} v &= \text{R}\, i + \text{L}\,\frac{di}{dt} \\ &= \text{RI}\sin(pt-\theta) + p\,\text{LI}\cos(pt-\theta) \\ &= \text{I}\sqrt{\text{R}^2+p^2\,\text{L}^2}\,.\,\sin(pt-\theta+\phi) \\ &= \text{V}\sin(pt-\theta+\phi) \end{aligned}$$

where $\phi = \tan^{-1}\dfrac{p\,\text{L}}{\text{R}}$.

Hence we get for the ratio

$$\frac{\text{P.D.}}{\text{open-circuit E.M.F.}} = \frac{\text{V}}{\text{E}} = \frac{\sqrt{\text{R}^2+p^2\,\text{L}^2}}{\sqrt{(\text{R}+r)^2+p^2\,(\text{L}+l)^2}}.$$

The self-inductance E.M.F. (see p. 130) is given by

$$l\,\frac{di}{dt} = pl\text{I}\cos(pt-\theta).$$

The magnitudes and phase relations of the various quantities are conveniently represented by a "clock-face" or vector diagram, as in Fig. 10, in which the counter-clockwise direction is taken as positive. Here OA represents the P.D., and OB the current. In order to obtain the open-circuit E.M.F., we have to add *vectorially* to the P.D. the armature resistance drop, rI, which is in phase with the current (AC in diagram), and the armature reactance drop, lpI, which is in quadrature with it (CD in diagram). The resultant vector OD gives us the open-circuit E.M.F.*

More frequently, however, it is required to find the P.D. from the open-circuit E.M.F., the current and power-factor

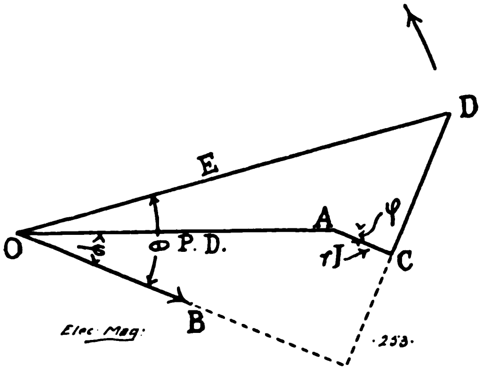


FIG. 10.

---

[*] In using such a vector diagram, it is more convenient to select the scale so that the lengths of the vectors correspond to R.M.S. instead of maximum values.

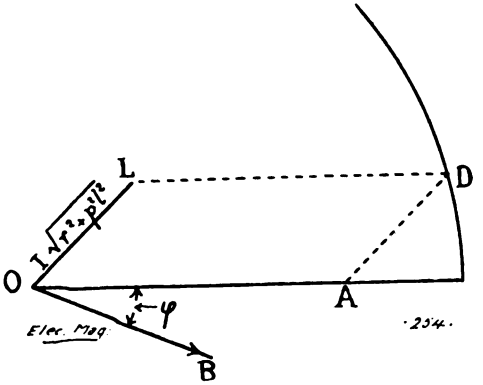


FIG. 11.

(cos ϕ) of the external circuit being given. The construction shown in Fig. 11 may then be used. Draw two lines, OA and OB (corresponding to OA and OB in Fig. 10), making an angle ϕ with each other. With O as centre and radius = open-circuit E.M.F. describe an arc. From O draw a line OL making an angle $\tan^{-1}\frac{lp}{r}$ with the line OB (*i.e.*, the current vector), and lay off a length $OL = I\sqrt{r^2+p^2l^2}$ (this represents the armature impedance drop, and corresponds to AD in Fig. 10; AD being the resultant of rI and lpI). Through L draw LD parellel to OA. Then LD = OA gives the P.D.

It is evident from the diagram that for a given value of the current the P.D. will very largely depend on ϕ. The greater ϕ, *i.e.*, the less the power-factor, the shorter will be the line OA. The following very elegant construction, due to Kapp, shows clearly the dependence of the P.D. on ϕ. Let OB (Fig. 12) be taken as the direction of the current vector. Draw $OL = I\sqrt{r^2+p^2l^2}$, to represent the armature impedance drop (the angle $LOB = \tan^{-1}\frac{lp}{r}$). With O as centre and radius = E, describe the circle 11'. In order to find the P.D. corresponding to any value of ϕ and to a given value of I, we have to subtract vectorially from E the vector OL; or, which comes to the same thing, *add* vectorially the equal, but oppositely directed vector OO'. Now adding OO' is equivalent to displacing the extremity of the E-vector through a distance OO' parallel to OO'. Regarding, for the sake of convenience, the direction of the current vector OB (and hence also that of OO') as fixed, and the directions of the E and V vectors as movable relatively to it, it follows that since the circle 11' is the locus of the extremity of the E vector, the locus of the extremity of the V vector will be obtained by displacing each point of the circle 11' through a distance = OO' and parallel to OO'. This amounts to displacing the entire circle 11' through the corresponding distance, *i.e.*, to describing a circle 22' whose centre is at O' and whose radius = E. The circle 22' is the locus of the V vector, so that for any given value of ϕ we can at once read off the corresponding value of V. The diagram shows at a glance that the V-vector OA increases with decrease of ϕ, and that when ϕ becomes negative (*i.e.*, when the current is in advance of the P.D.), V may even exceed E, as shown by OA' in the diagram.

The construction of the above diagrams involves a knowledge of r and lp, the armature resistance and reactance. The former is easily found by any ordinary method for the measurement of resistance,

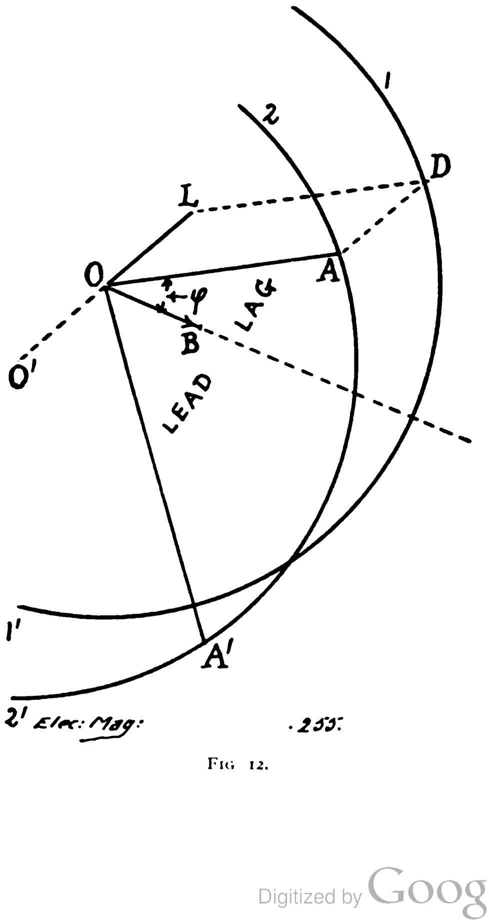


FIG. 12.

while the latter may be determined from the impedance, $\sqrt{r^2+p^2l^2}$; this latter quantity being measured by short-circuiting the armature through an ammeter of negligible resistance and inductance, and dividing the open-circuit E.M.F. by the short-circuit current.

It has already been mentioned (p. 237) that the fictitious armature field (which gives rise to the self-inductance E.M.F.) may be supposed to be split up into two components: (1) the armature leakage field, which developes an E.M.F. termed the leakage self-inductance E.M.F., or leakage E.M.F.; (2) the field whose lines become fused with those of the impressed field, and which we may conveniently refer to as the *fusion field.* We may speak of the armature leakage flux due to unit current as the *leakage self-inductance* (or leakage inductance). Endless confusion has been caused by the use (or rather *abuse*) of the simple term *inductance* to denote *leakage inductance*, and by the seeming inability of some writers to discriminate between the two. It may be well to caution the reader who intends consulting the literature of the subject against the frequent abuse of the term "self-induction" (or inductance); in most cases, a little attention to the context enables one to determine in what sense the term is used; but not unfrequently it is used with such extreme vagueness as to leave the reader entirely in doubt regarding its exact meaning.

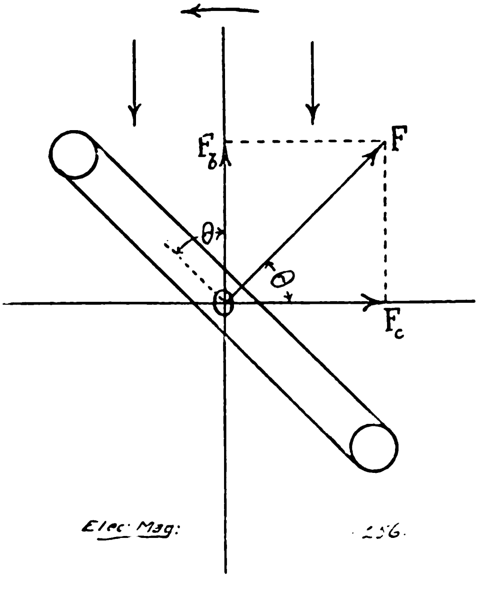


FIG. 13.

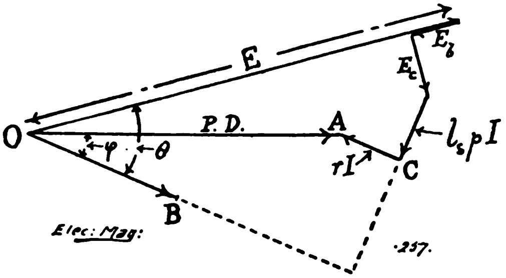


FIG. 14.

If we denote the leakage self-inductance by l_s, we may write

$$l = l_s + l_f,$$

where l_f is the part of the inductance contributed by the fusion field. Now, many writers prefer to go a step further, and to resolve the fusion field itself into two components: *(a)* A component whose magnetic axis is coincident with that of the impressed field, and which would therefore produce a direct weakening (or strengthening) of the impressed field); *(b)* a component whose magnetic axis is normal to that of the impressed field, and which produces a simple distortion of it, without any strengthening or weakening of its total flux. *(a)* forms the *back-field*, and *(b)* the *cross-field* of the armature. It is very important to observe that, for a given armature current, the leakage field is independent of θ (the angle by which the current lags behind the open-circuit E.M.F.); while the relative values of the back-field and cross-field depend entirely on θ. All these fields reach their maximum values when the armature current is at its maximum. In Fig. 13, which corresponds to the diagrams of Figs. 2-7, the rotating loop which forms the armature of our ideal alternator is shown in the position for which the current is at its maximum. The fusion field is represented by the (alternating) vector OF; we may resolve it into the back-field $OF_2 = OF \sin\theta$, and the cross-field $OF_c = OF \cos\theta$. From this it is evident that *the de-magnetising effect of the armature current is proportional to* $\sin\theta$. It will further be seen that the E.M.F. to which the back-field gives rise (e_b) is in phase with the open-circuit

E.M.F.; while that to which the cross-field gives rise *(e_c)* is in quadrature with the open-circuit E.M.F. We may therefore regard the total inductance E.M.F. as made up of the following components:

(1) The leakage E.M.F., in quadrature with the current.
(2) The back-field E.M.F., in phase with the open-circuit E.M.F.
(3) The cross-field E.M.F., in quadrature with the open-circuit E.M.F.

Taking this analysis of the E.M.F. into consideration, we get the complete vector diagram shown in Fig. 14, which should be compared with Fig. 10, from which it differs in the substitution of three component vectors, $l_s p$I, E_c, E_b, for the single vector, lpI, of Fig. 10.

In the case of our ideal alternator, the resolution of the self-inductance E.M.F. into three components, as just explained, presents absolutely no advantage, as it is more or less arbitrary, and unnecessarily complicates the problem. There is, however, a certain amount of justification for it in the case of actual machines, as will be seen later.

PRACTICAL APPLICATIONS OF ALTERNATOR THEORY.

Before dealing with commercial forms of alternators, it will be convenient to consider briefly the practical uses to which a theory of such machines may be put. The first important application occurs in the design of alternators. The object of the designer is to secure the maximum of output for a given amount of material, subject to certain conditions which the machine is required to fulfil. One of these conditions is the limit of "voltage drop," at constant excitation, between open-circuit and full-load *current*, for a given power-factor. It is this permissible "drop" which really determines the size of the machine; for if the restriction were removed, we could easily increase the output per unit weight of materials, and so cheapen the construction, by simply increasing the amount of copper on the armature: *i.e.*, the ampère-turns, and with them the leakage and fusion fields. The immense importance to the designer of even an approximate method of pre-determining the "drop" will now be apparent. For if the design be faulty, resulting in an excessive "drop," then the only way out of the difficulty is the construction of an entirely new and larger machine.

(To be continued.)

Alfred Hay

The Special Articles Section of *The Electrical Magazine* can always be looked to for contributions on important subjects by prominent writers. Matters tersely treated in the other sections of the magazine, or not included therein, will be found enlarged upon in this section. A particular feature will be made of articles in which important apparatus, installations, processes, etc., will be fully described and illustrated. No other Electrical journal can devote the same attention to such subjects.

ELECTRICITY APPLIED TO MINING AND METALLURGY.

III. Blast Furnace Gas Engines, &c.

By PERCY R. ALLEN, A.M.I.C.E.

(Continued from page 250).

The application of electricity to the transmission of power in iron and steel works has been much hastened and facilitated by the readiness which the Continental ironmaster has displayed in adopting the idea of utilising the waste gases from blast furnaces to drive dynamos coupled to large gas engines.

Blast furnace gas is usually regarded as a lean gas, poor in combustible, the average composition being:

Carbonic Acid (CO_2)	8·78
Carbon Oxide (CO)	29·93
Hydrogen (H)	1·62
Nitrogen (N)	59·67
	100·00

In some cases there may be a small percentage of marsh gas, and rather more hydrogen.

About ten years ago, Mr. H. B. Thwaite suggested and demonstrated in practice that blast furnace gas, though poor in quality, was, if properly cleaned and worked with a fairly high degree of compression before ignition, a perfectly suitable gas for gas engines; but although both he and Mr. W. H. Booth have been proclaiming this fact ever since, up to quite recently the matter has been regarded with singular apathy in this country. The mere enumeration of the large gas engines working with blast furnace gas on the Continent would fill several pages of this magazine, while even now the number working in Great Britain could be recorded on the fingers.

Independent figures obtained by the writer in Germany agree very closely with those of Thwaite obtained from English practice; that is to say, that taking a furnace making 7 tons per hour, or 168 tons per day (a very moderate size nowadays), enough gas is generated to furnish 5,880 h.p. continuously, after having deducted what is necessary to heat the blast and work the blowing engine. That is, of course, assuming the gas is utilised in gas engines of fair efficiency, taking, say, from 90 to 100 cubic feet of gas per horse-power at full load.

That such a source of power should not have been utilised to the very last cubic foot seems almost inconceivable in these days of bad times and hostile tariffs. On the Continent these conditions have been appreciated, and as fast as large gas engines and dynamos can be delivered, so all old boilers—and, for the matter of that, new boilers—and engines are being removed for the gas motor. When people realise that a blast furnace is the cheapest of all gas producers, it is almost possible that pig-iron may become a bye-product in the production of cheap gas for motive power.

About the same time that Mr. Thwaite was experimenting in England, the John Cockerill Co., of Seraing, near Liege, Belgium, began, apparently independently, to study the question, and ultimately took up and developed the Delamare-Deboutteville engine, which, with their own improvements, is now generally known as the Cockerill engine. The first large engine of this kind to attract public attention was the gas-driven blowing engine shown at the Paris Exhibition, and now in use—among a number of others—at their own works at Seraing. It ought not to be forgotten that the present position of the large gas engine is due to a great extent to the pluck and energy of Mr. Greiner, the managing director of the Cockerill Co., and the technical skill of Mr. Kraft, their engineer, coupled with the financial resources of the Cockerill Co.

The Cockerill gas engine is made by several firms (under licence) on the Continent, and by Messrs. Richardsons, Westgarth & Co., in Great Britain. Upwards of 53,000 h.p. of engines are now at work on blast furnace gas on their system, the best known installation being at Differdange, where nine engines, of 600 h.p. each, have been working for several years.

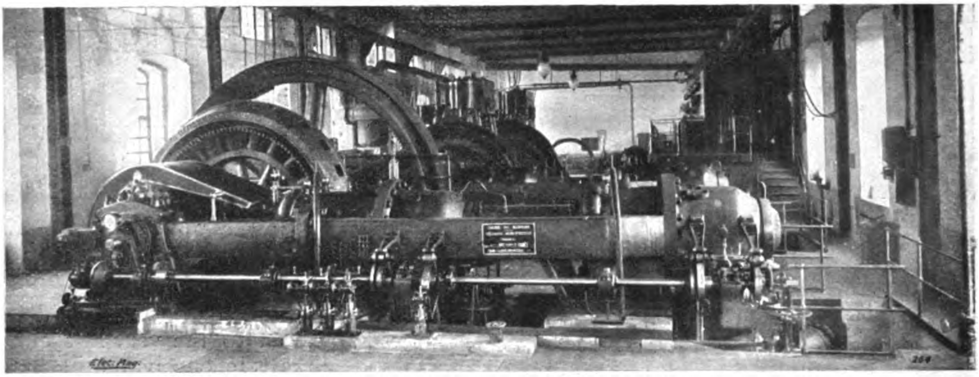


Fig. 1. 600 h.p. Gas Engine.
(Kladno Steel Works).

The engine shown in Fig. 1, built by Messrs. Breitfeld, Danek & Co., of Prague, for the Kladno Steel Works, is not one of the latest designs, but it is especially interesting, as it definitely settled the question as to the parallel working of gas-driven alternators. The gas engine had to be designed to run in parallel with two alternators already in existence, driven by two 500 h.p. compound steam engines, the cylinders of which can be seen in the background of the picture

The gas engine, of 600 h.p., at 150 r.p.m., has four open ended cylinders, two on each side of the armature and flywheel, each cylinder being 27½ in. diam. and 31½ in. stroke. The alternator field has 20 poles, and the armature has 120 slots; the voltage is 550, with a periodicity of 25 cycles, the same as the steam-driven sets. The dynamo was made by Kolben & Co., of Prague, and an electro-magnetic brake action on the flywheel was provided to help to get the machines into step. This has, however, never been employed; but a choking coil, introducing an inductive effect in the path of the compensating current, is made use of. One half of the engine was started some time before the other; but even when there were only two cylinders in use, there was no difficulty in working in conjunction with steam engines. Fig. 2 shows the characteristic curves of steam and gas-driven machines, the path of intersection being where the machines are doing the same work.

The design of the Cockerill engine has been somewhat modified since the Kladno installation, and, while retaining the Otto cycle, the cylinders are now closed at each end and made double acting. Thus, with a pair of cylinders placed tandem an impulse is obtained every stroke. The large engine, of 3,000 h.p., being built by the Cockerill Co., and at first intended for the St. Louis Exhibition, is arranged in this manner with two double acting cylinders, each 51¼ in. diam. by 55¼ in. stroke, and is intended to run at 85 r.p.m. It has recently been decided to exhibit this engine at Liege in 1905.

The Gasmotoren Fabrik Deutz, whose works near Cologne may be regarded as being the birthplace of the Otto cycle type of engine, have for many years past built large gas engines, using blast furnace

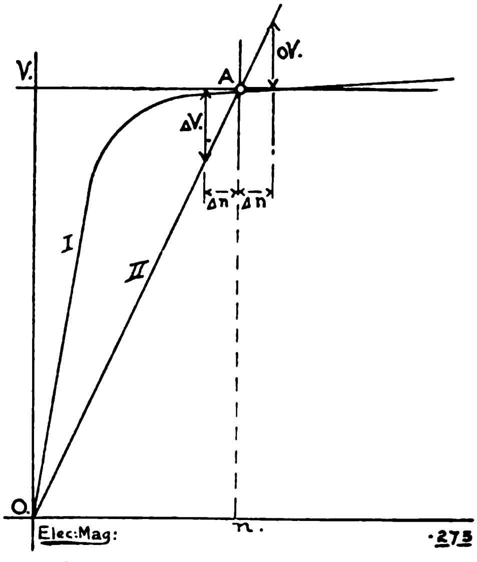


Fig. 2. Gas and Steam Engine Curves.

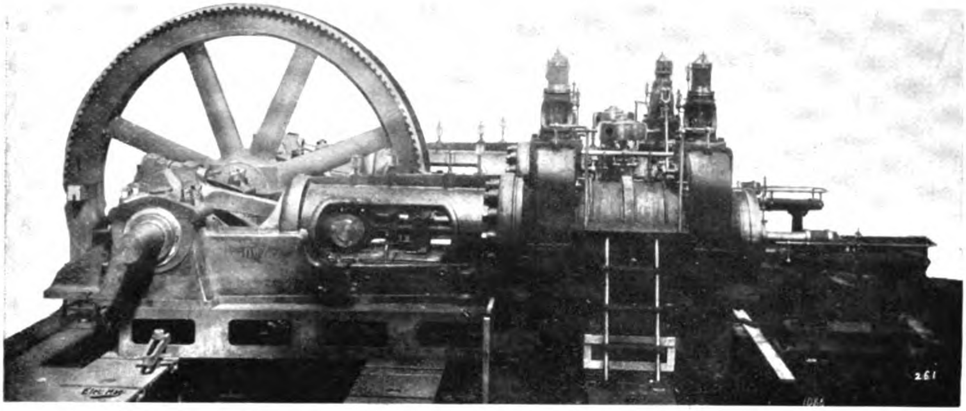


FIG. 3. TWIN CYLINDER BLAST FURNACE GAS ENGINE.

gas for driving alternators, the Gutehoffnungshuette Co. having had more than a dozen of these engines at work for several years, mostly driving three-phase generators. Until quite recently the engines built by the Deutz Co. have been of the open trunk type, and, where increased power was necessary, this has been obtained by placing the cylinders *vis-a-vis*, and in the larger sizes by duplicating this arrangement and having four cylinders in all. Practical disadvantages arise from having the cylinders facing each other, and the Deutz engines are now built with cylinders closed at each end and operating on the Otto cycle on each side of the piston, the general design resembling the new type Cockerill, and also the latest Nurnberg engines. They are made either single cylinder, two cylinders tandem, or twin, with the two cylinders side by side; fig. 3 shows one of these twin cylinder engines working with blast furnace gas and driving a dynamo by belt. The Deutz Co. are prepared to build gas engines to couple direct to generators up to 6,000 h.p.

The Nurnberg engine, Fig. 4, built at the Nurnberg works of the Augsburg-Nurnberg Co., is another design of engine largely used in Germany for electric driving with blast furnace gas. This type has also a closed cylinder, and works with the double acting Otto cycle. Regulation is readily effected by varying the amount of gas, separate eccentrics with a trip gear controlled by the governor being used. Special attention has been paid in designing this engine to ensure the accessibility of all the interior

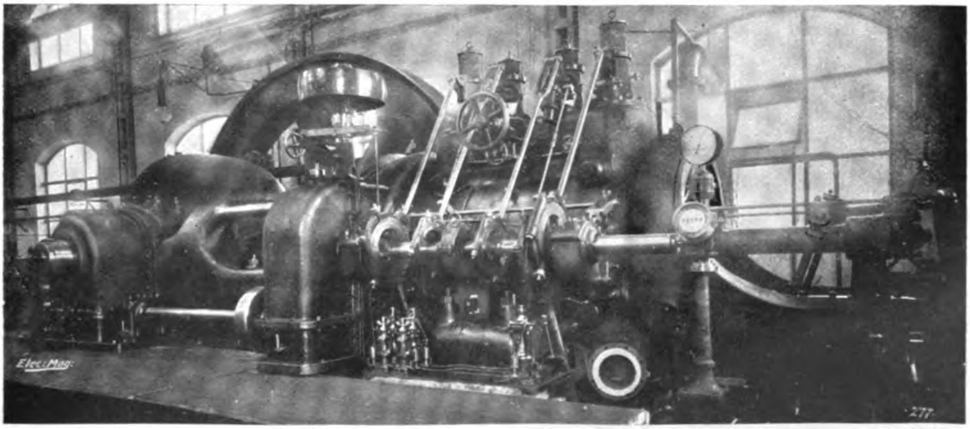


FIG. 4. NURNBERG BLAST FURNACE GAS ENGINE.

parts, and, altogether, it is obvious a lot of thought has been given to the details of this design. The electric ignition arrangements are rather peculiar. Current is supplied from some external source, and passes through a kind of commutator with adjustable brushes, and then through an induction coil, and on to the sparking plugs. The point of ignition can be varied by moving the brushes relatively to the commutator. A good fat spark is certainly produced by this arrangement, even when starting slowly.

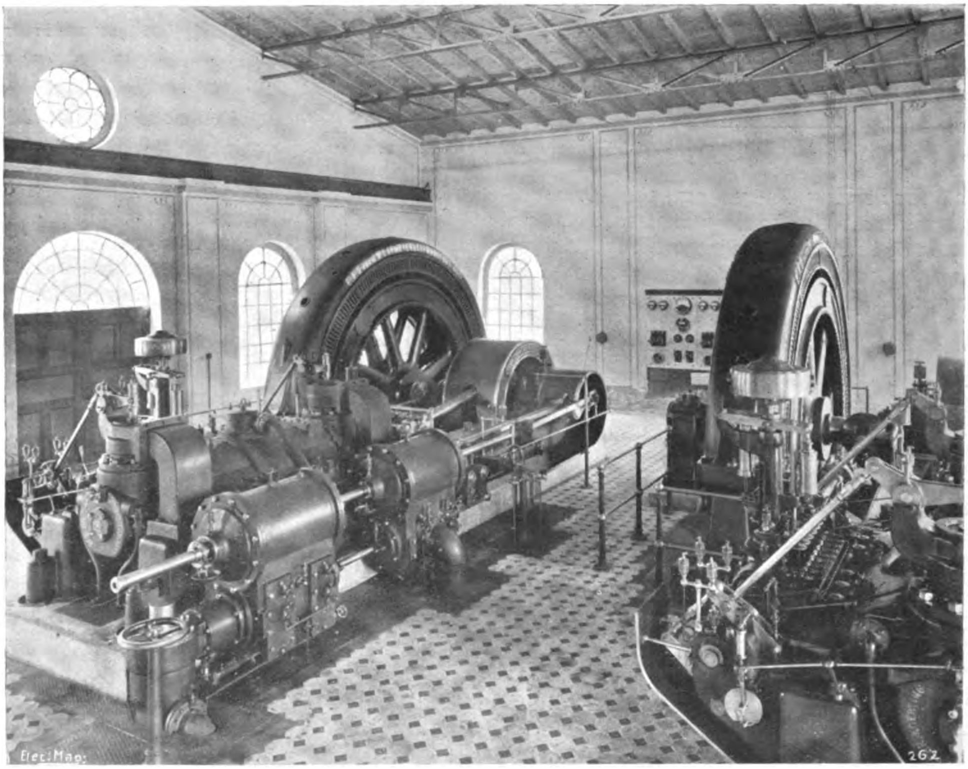


Fig. 5. 300 h.p. Korting Gas Driven Generators.

The three engines just referred to, *viz.*, the Cockerill, Deutz, and Nurnberg, may be taken as representing the old Otto cycle applied to double acting engines. The Korting two cycle engine, although a late arrival in the ranks of large gas engines, is coming rapidly into use for dynamo driving, both with blast furnace and coke oven gas. In this engine there is an impulse imparted to the piston every stroke, just as there is in a steam engine, and this is obtained by having a long cylinder with an exhaust port in the centre, and using a long piston which keeps the port closed except for a short period at each end of the stroke. No moveable exhaust valves are used, and there are only two plain mitre admission valves. The air and gas are fed to the cylinders by means of independent pumps, and while the exhaust port remains open a scavenging charge of air sweeps out the products of combustion. Fig. 5 shows a pair of Korting engines of 300 h.p. each coupled direct to dynamos, installed at the Gewerkshaft Messel, near Darmstadt. These engines are of comparatively small size, but they are interesting as running on coke oven gas which is obtained from bituminous lignites and contains from 50 to 55% hydrogen. Before going to the engine this gas is washed and cleaned, and diluted with exhaust gas so as to obviate premature ignition. A large Korting engine giving 1,000 h.p. in one cylinder has lately been installed at Gutchaffungshutte, using blast furnace gas, driving a three-phase dynamo.

In recording what is at present being done on the Continent with blast furnace central stations, mention ought certainly to be made of the Ilseder Hutte, where a large installation, driven entirely by blast furnace gas, is being put down as fast as the engines can be delivered, and in this case the Oechelhauser engine has been chosen. Fig. 6 shows the first pair of engines erected, with the three-phase dynamo, giving 10,000 volts, coupled to the crank shafts. This engine has two pistons which move in opposite directions in a single cylinder open at both ends, which pistons are connected to a three-throw crank, having the outside cranks at 180% to the inner one, the effect being that as the cranks revolve the pistons alternately approach and recede from one another. Two sets of ports are provided at one end of the cylinder, one to admit the air and the other the gas, the exhaust ports being placed at the other end of the cylinder. The gas and air are supplied, under about 5 lbs. or 6 lbs. pressure, by means of a pump, which, when the exhaust port has opened, lets a scavenging charge through; then the gas port opens and air and gas enter, forming the charge, which is compressed as the pistons close the ports and approach one another. The charge being fired on or near the dead centre, it will be understood that this arrangement gives one impulse every revolution against one impulse every stroke of the double-acting Korting. The disposition of the reciprocating parts permits a very good balance to be obtained, and there are no valves whatever near the working cylinder. The present installation at Ilseder is intended for six sets of 1,000 to 1,200 h.p., but provision is made for an early extension to double the plant. The engines run at 120 r.p.m., and the periodicity is 50 cycles per second. Current is transmitted by overhead lines (about four miles) to the rolling mills at Peine. The authorities at Ilseder must have been strongly convinced of the advantages of gas-driven dynamos, as these are intended to supersede a very perfect and modern steam-driven plant put in only three years previously. The writer has somewhat dilated on the large gas-driven dynamo, but the complete and most economical utilisation of blast furnace gas opens a field for the electrical engineer and an investment for the capitalist, the importance of which is not

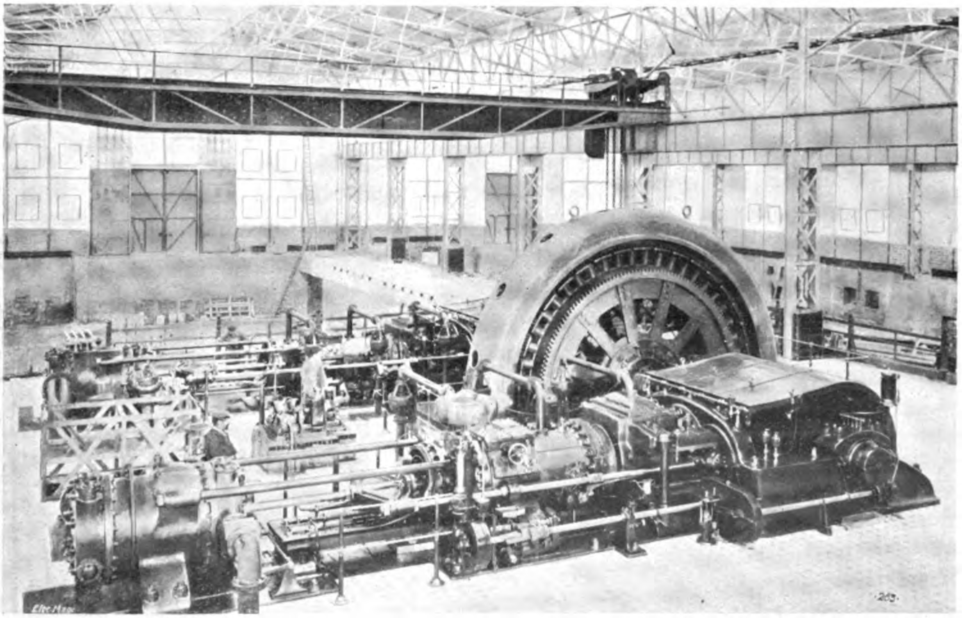


FIG. 6. OECHELHAUSER GAS ENGINE AND GENERATOR.

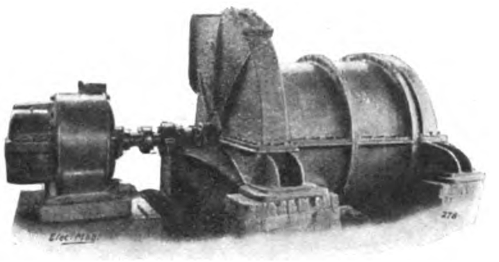


Fig. 7. Theisen Gas Washer. Motor Driven.

realised as yet—at all events, in this country. The engines already described may be considered the leading types used with blast furnace gas, and there are at present at work on the Continent about 154,000 h.p. of large engines working with blast furnace or coke oven gas.

If the same amount of this gas was burnt under steam boilers only one quarter of the power would be delivered to the dynamos, so that even during the comparatively short time that the gas engine has been introduced, it has put the iron-making industry in possession of over 100,000 h.p. as a free gift to help in the reduction of the cost of manufacture. Of course one ought to take into consideration that the capital expenditure on gas cleaning plant, gas engine, and dynamos would be somewhat greater than with a combined steam driven plant, but the attendance and upkeep will be no more, and the balance of advantage is overwhelming in favour of the gas engine. In comparing a blast furnace installation with a water power central station, it should be borne in mind that, although the water costs nothing in the first instance, some one generally wants something for it before it arrives at the power house, and that each unit of dynamo and turbine as it is put down has to earn interest on a proportionate capital outlay in the form of canalization work, culverts, tail races, and a pretty substantial power house, while in a blast furnace the cost of erection is directly chargeable against the cost of making iron, and is the same whether the gas is utilised in the most efficient gas engine, or is burnt to waste at the furnace mouth. If the blast furnace makes iron for sale in the form of pigs, more gas may be produced than is necessary to run the steel department, and the possible disposal of such surplus power is beginning to attract the attention of the iron master and his advisers. One of the obvious openings is to utilise some of the energy for electric furnaces for the production of high grade steel and ferro compounds, the commercial production of which depends entirely upon the cost of current.

Before leaving this portion of the subject a word of warning should be said about the cleaning of the gas. The gas must be clean, and thoroughly clean. This seems a very simple proposition, but it has cost a great deal of money to bring home the necessity for it, and the question has been somewhat complicated by the fact that some ores give off dust which is much more objectionable and difficult to deal with than others. Dust from furnaces working haemitite, although objectionable inasmuch as it dilutes the calorific value of the gas, has somewhat of a lubricating nature, while other dust would ruin a cylinder in a few hours. All sorts of different devices have been proposed and tried—the gas has been made to change its direction by zig-zag mains, with settling boxes at the angles, and combinations of small pipes expanding into large ones have been used; washers and scrubbers founded on gas works practice have been experimented with; out of all these different arrangements a comparatively simple system has ultimately been evolved, having a fan or generally two fans in series, and injecting a copious supply of water into the case near the centre. This arrange-

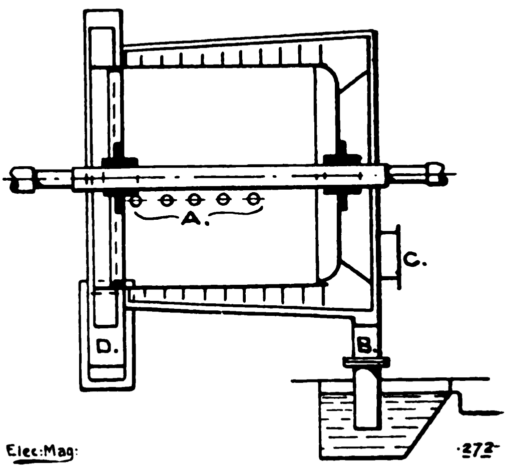


Fig. 8. Section through Theisen Gas Washer.

ment both cools the gas and washes it; if the fans are driven at the right speed and enough water is sent in, the gas can be purified down to 0·15 to 0·20 grammes per cubic metre, or as pure, or purer than the surrounding atmosphere; but a considerable amount of power is wanted, in some cases as much as 8% of the output of the gas engines. Fig. 7 shows an external view of the Theisen washer with electric motor, and Fig. 8 shows a longitudinal section. A number of other machines are at work on the Continent, notably at a plant at Ilseder-Hutte, and the apparatus is now being built in this country by Messrs. Richardscns, Westgarth & Co., Ltd. The sketch explains itself. The gas enters at one end of a large casting and is sucked through by a fan at the other end, being whirled round in a series of pockets, where it is brought into contact with the injection water, which mixes with the dust and flows out in a kind of soup through a water lute at the bottom. These machines are generally motor driven, and like fans, consume a fair amount of power, averaging from 7½ to 10% of the b.h.p. As to the cooling effect on the gas, at the works at Schalke, tests taken showed that gas enters the machine at 292°F, and leaves it at 86°F; the water entering at 54°F, and coming out at 131°F. That the adequate cooling and cleaning of the gas is a matter of great importance is borne out by the results obtained at Kladno, where over 60% more power was obtained in the same engine by properly treating the gas. The Clemang gas purifier, which is a vertical apparatus having a kind of helical blade, throwing the injection water against the sides of an annular casing is another apparatus used at Luxemburg and district. It is claimed for it that it only requires a very small amount of power to drive it, but the writer has had no actual experience of this machine.

The development of the Voght type of engine in which the impulse of the explosion is transmitted to the working piston through the medium of a water buffer, will be watched with much interest by the users of blast furnace gas, but enough has been said to prove that the electrician already has in existing large gas engines a perfectly reliable means of generating current from waste blast furnace gas. The development of the Kent coalfield and the re-working of the Sussex iron ore deposits, in combination with foreign ore brought in large bulk to Dover, might mean that enough power could be generated within 40 or 50 miles of London to drive every street car and railway in the metropolis.

Having in this number dealt exclusively with the generation of the electric current at the blast furnace, the two following and concluding articles will deal with the utilisation and distribution of it in steel and iron works.

(To be continued).

Percy R Allen

The next instalment of this series by Mr. Allen should be read by all Electrical men interested in the application of electric power in steel and iron works. So little has been done in this country to utilise blast furnace gas to generate electricity for power purposes in metallurgical works, that we feel compelled to draw attention to the work of our Continental neighbours in this respect. As the pioneer producers of steel and iron, it behoves us to take every advantage of modern methods in these processes. We cannot afford to remain idle while other nations forge ahead of us. The article on the next page will give full emphasis to the importance of this remark.

ELECTRICAL LIFTING APPARATUS FOR IRON AND STEEL WORKS.

By AUGUST REICHWALD.

THE employment of electric motors, has rapidly extended from the lighter types of machinery to extremely heavy apparatus, which at one time was operated exclusively by steam or hydraulic power. In cases where electrical energy can only be procured by installing special steam driven plant, or from the mains of some local authority, the proprietors of works requiring power are not always ready to introduce electric driving, on grounds either of initial expenditure or maintenance of plant. Where cheap sources of power are at command, however, as with blast furnace gas, the generation of electrical power and its application to almost every operation in steel works, has presented economical advantages not easily overlooked. Consequently, it is not a matter for surprise, that electric motors have been, and are being rapidly and successfully applied under working conditions, at one time considered beyond the capacity of such machines. The extreme flexibility of control, which characterizes all electric motors, makes them particularly adaptable to the handling of heavy weights, and the multitudinous examples of cranes, hoists, lifts, winches, etc., now driven by electrical means, afford a greater testimony to their reliability and efficiency than any amount of argument could possibly do. Electric cranes have rapidly become standardized, and the fixing and control of the motors is now conducted on recognised lines, consequently, in presenting descriptions of such devices, the chief engineering features of the apparatus will be both interesting and important, in that the construction of the particular type will form a guide to the work the motors are called upon to perform. In the following article, some prominent examples of electric cranes are described, and in the light of the above, no excuse is made for dwelling at some length on the engineering, rather than the electrical, merits of the types dealt with. The entire series depicted are the product of Messrs. Bechem & Keetman Duisburger Maschinenbau, Act. Ges. of Duisburg.

To English crane makers and users, the examples may prove instructive, while to electrical engineers they afford yet another instance of the manner in which motors can be used under really trying load conditions. A mere reiteration of the motors used, the gearing employed, and controlling apparatus, has been avoided in order that due prominence may be given to the work demanded of the particular type under consideration. The writer's object in emphasising these features is to impress the manager of steel works with, firstly, the desirability of employing mechanical devices in every process, involving weight lifting and transportation, and secondly, the necessity for operating such devices by the agency of electricity.

The utilisation of blast furnace gas has not been encouraged in this country, but with the prospect of employing energy thus generated for operating even the heaviest machines in steel works, a real inducement is offered for installing such plant. The example of Continental engineers may well be followed in this respect, as what has

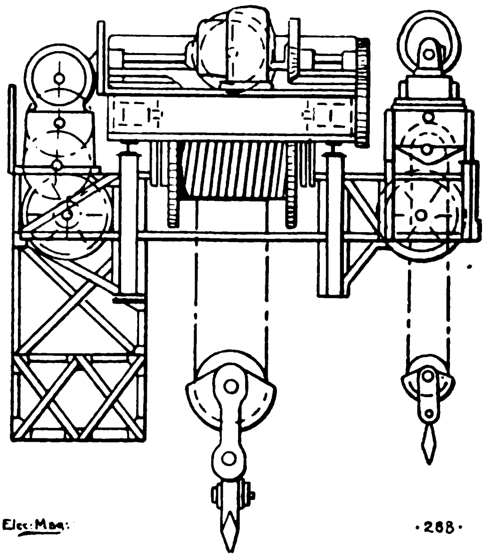


Fig. 1. Double Hook Electric Crane.

there been done can be equally well accomplished under almost identical conditions by British steel makers. Even where the capital outlay on generating plant is not deemed expedient, the necessary energy can be taken from some power company. Several large concerns have either been started or are now building in the principal coal fields, consequently there is little excuse for neglecting the undoubted advantages offered by the supply mains of such undertakings.

In the following descriptions, little or no reference is made to the type of motors employed on the apparatus, chiefly because the direct and alternate current types can be generally adapted to almost every condition of load. Where at one time the direct current motor was regarded as exclusively suited to crane work, experiment, experience, and development have established an equally wide field for the alternate current form. It would therefore be difficult to specify either as directly applicable to the functions of a particular machine. The writer holds no brief for either design, preserving rather a middle course which admits of the employment of that class of motor which either the local supply will permit, or the peculiarities of the machine sanction.

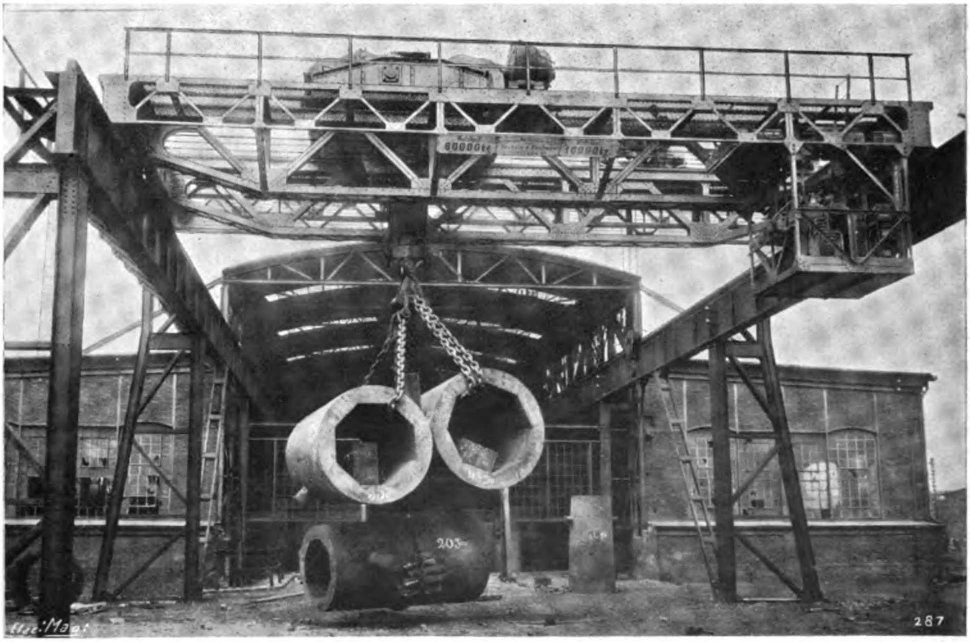


Fig. 2. Double Hook Crane, Showing Girder Work.

Overhead travelling cranes for carrying casting ladles have hitherto been provided, in addition to the main hoist, with an auxiliary hoisting gear, placed on a common crab frame. This auxiliary hoist can be used for tilting the ladle when pouring out the slag, and, as far as the lifting capacity of the crab permits, for drawing off the casting moulds, conveying the blocks, and even doing occasional repair work on the furnace itself. If this auxiliary hoist be placed on the crab with the ladle hoist, so that the hooks of both are in the centre plane of the crane bridge, part of the working field spanned by the crane bridge cannot be served by either hook when the crab is at the end of its travel. The crane shown in Fig. 1 remedies this drawback, in that the crane bridge is composed of two pairs of girders placed parallel and close together, connected by a narrow platform, the girders thus forming separate runways for each of the two crabs. By the side of the outer main load girder a platform girder is placed and this carries the crane travelling gear. All the bridge girders are joined to the two end

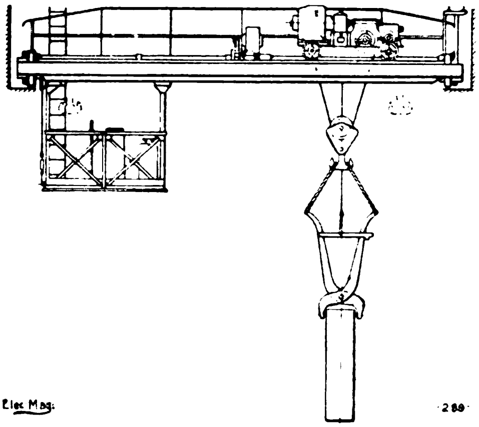


FIG. 3. 4 TON ELECTRIC TONG CRANE.

carriages of the crane, and the hooks of the two crabs can thus cover the entire breadth of the working field spanned by the crane.

Two overhead travelling cranes of this type, each fitted with hooks of 80 and 10 tons respectively, and having a 46 ft. span, have recently been installed at the Martin Steel Works Department of the Gutehoffnungshuette at Oberhausen, and at Messrs. Haniel & Lueg at Duesseldorf-Grafenberg. Another crane of this type of 60 and 10 tons capacity respectively, with 52 ft. 6 in. span, has also been supplied to the Iron Foundry Department of the latter firm. Fig. 2 explains clearly the girder work of such a crane, and also the controlling arrangements. Spur gearing is exclusively used, and the motor gearing throughout runs in oil.

The Tong crane of 4 tons capacity, shown in Fig. 3, is a standard type on the three-motor system. It is provided with a special arrangement to enable it to lift ingots out of the pits. No workman, other than the crane operator, is needed to make the tongs grip the blocks. The tongs are suspended from the double hook, and held apart by a pawl. After lowering the tongs into the pit, and hanging them over the block, the pawl is drawn off by a rope, and the tongs close by their own weight. The grip thus created is further increased when lifting the block, by the weight of the latter and by the joint lever effect of the tie band, so that the block is held securely. When setting down the block and relaxing the tackle, the tongs open again. The special method of suspending the pulley-block to the rope tackle, the ropes of which spread apart at the top, entirely prevents the load oscillating, so that the various movements can be safely carried out. Two cranes of this type of about 39 ft. 4 in. per minute lifting speed, 124 ft. 10 in. speed of crab, and 328 ft. speed of crane, are in operation at the Burbacher Huette (Burbach-Saar).

Fig. 4 shows a crane designed on the same lines. It was, however, not constructed to meet any additional requirement, but simply to comply with a specific purpose. On account of the high speeds of all movements it seemed impracticable to suspend the tong by ropes, and they were therefore guided rigidly. The crane bridge is composed of the two load girders connected and stiffened with the platform girders by strapping work. From the crab downwards a frame of sectional iron extends, carrying a rod with the tongs at its lower end. The rod is suspended from "Gall" chains, the pulleys of which are motor-driven by means of twin worm and wheel with reduced axial stress. The tongs work in exactly the same manner as those above described, the only difference being that the detaining mechanism is arranged apart from the tongs at the upper end of the rod. By pressing a foot lever a wire rope attached to the latter draws the pawls out of their notches and

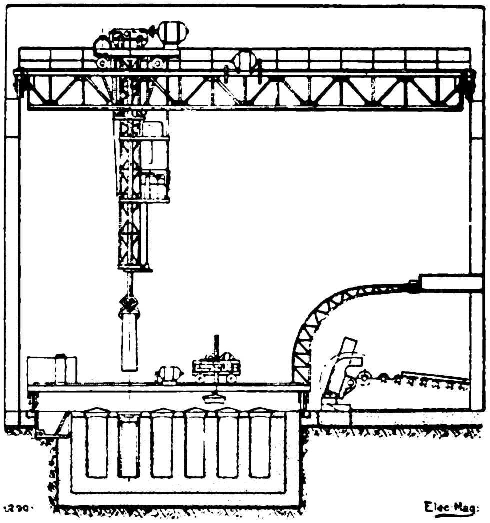


FIG. 4. SPECIAL TONG AND COVER LIFTING ELECTRIC CRANES.

the tongs close, gripping the block when they are raised. When lifting and lowering, the rope is evenly wound upon a drum. The rod is suspended in a ball step bearing, and can, if necessary, be so turned by the operator that the jaw punches of the tongs grip the block faces vertically.

The speeds of the various movements are fairly rapid, *i.e.*,

Lifting	72 ft. per minute.
Crab traverse	262 ft. per minute.
Speed of Crane	689 ft. per minute.

Lifting, crab traverse, and crane travelling are each effected by a separate motor. Further, all gears are fitted with electromagnetic brakes, to ensure quick and safe working.

Three of these tong-carrying cranes have been built for the Gutehoffnungshuette at Oberhausen, who have also been supplied with the cover lifting crane shown in Fig. 4. This crane travels in advance of the tong-carrying crane, lifts the covers from the pits to be served, and carries them aside to make room for the tongs. The curved jib is fitted with sliding contacts to collect the current, but the jib can be arranged to suit local requirements.

Block Charging Cranes.

For executing movements which must be rigidly adhered to through a limited distance, a constant power must be exercised during this movement and also after stopping. For this reason press-water must be considered the most suitable means for transferring power, as by this means the desired effect can be obtained in a simple manner when using trustworthy machines.

The block charging crane shown in Fig. 5 has been constructed on the electro-hydraulic system, with a view to meeting these requirements.

The crane comprises a crane-bridge and travelling crab, the latter bearing a square framing extending downwards and surrounding a revolving tower. This tower is suspended to the crab, and the horizontal gripping rod is secured to it. The travelling movements of the crab and of the crane-bridge, and the revolution of the inner framing are separately effected by electric motors. The movement of closing the tongs and of taking off the block from the bottom of the furnace is effected hydraulically.

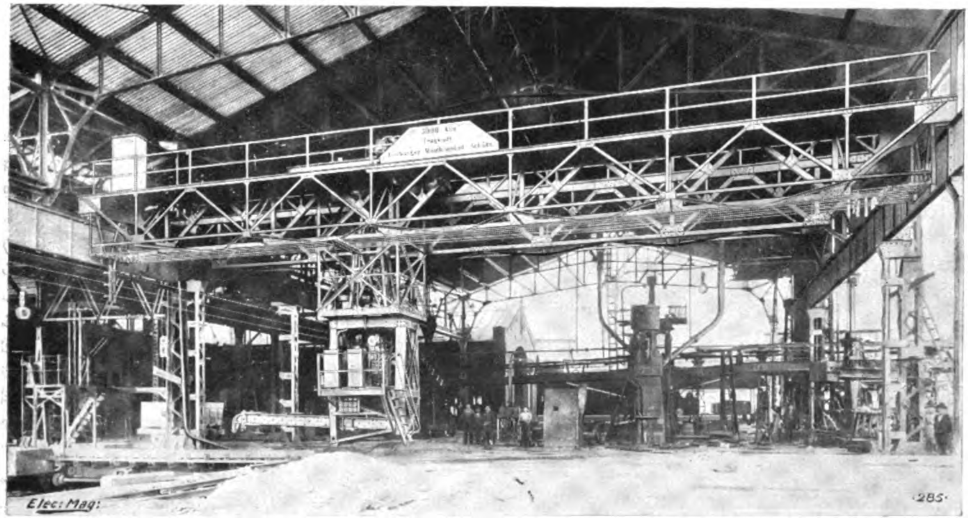


FIG. 5. ELECTRO-HYDRAULIC BLOCK CHARGING CRANE. OVERHEAD TYPE.

The press-water is produced by an electric plunger pump with three cylinders; the pump being fitted with an automatic arrangement by which the motor of the pump is started and stopped as soon as a working pressure of 60 atmospheres in the air chamber is obtained. Several cranes of this type for handling blocks of 3 tons and 5 tons weight have been successfully

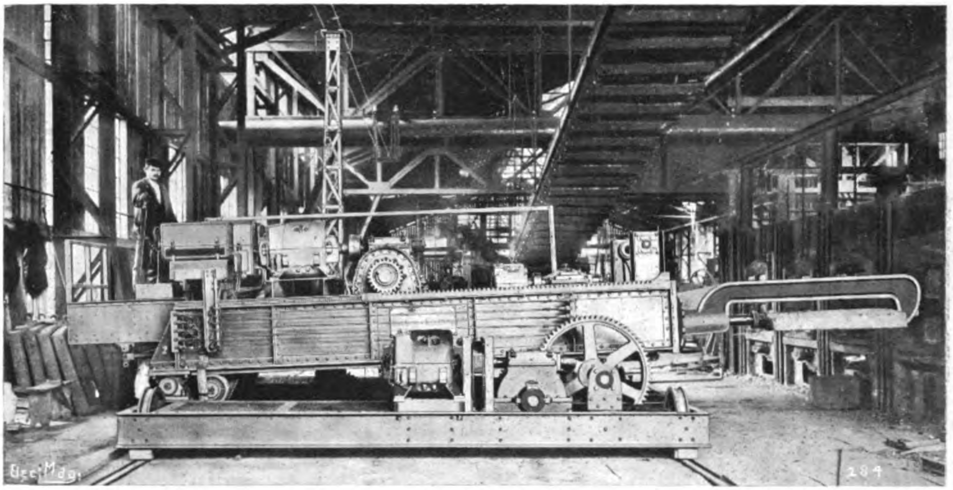


Fig. 6. 4½ Ton Electric Charging Machine. Floor Type.

operating for some time at the Oberschlesische Eisenbahn-Bedarf-Act. Ges. at Friedenshuette and the Société Métallurgique Dnieprovienne at Kamenskoje.

Fig. 6 shows a charging machine which travels upon the floor of the foundry. Two 4½ tons machines of this type have been supplied to the Burbacher Huette. In their case the horizontal tongs grip the block at the ends, and their efficiency is dependent on gravity, utilising the weights of the tong-arms and of the block respectively, all motor driving being avoided.

The arrangement of the machine is explained as follows:—The car frame of structural iron carries a tilting bearing for an up and down moving table placed on the top, farthest away from the furnace. This table is formed of two sheet girders connected with each other. The other supporting points of the table are two crank-tappets which press under the girders and are driven by a separate electric motor with gearing to move the table up and down for lifting the block from the bottom of the furnace. Upon the girders of the table the crab travels with the tongs and carries besides its travelling gear also a separately driven revolving gear which permits of turning the tongs round their longitudinal axis, and of turning the blocks round by 90 degrees and placing same into the furnace.

A block-conveying carriage, constructed for dealing with blocks of 3 tons weight as used at Roechling's Iron and Steel Works for conveying ingots to the tables in front of the furnaces, is shown in Fig. 7. This carriage is interesting on account of its various movements. The gears for lifting and slewing the block and those for travelling the carriage are driven separately by three-phase-current motors, the current for which is conveyed through sliding contacts from an underground conduit. Two carrying arms, each forming an angle, are pivotted to the top of the jib. When raising and lowering the jib, these arms always remain parallel. As the blocks must sometimes be deposited upon the tables, provision has been made

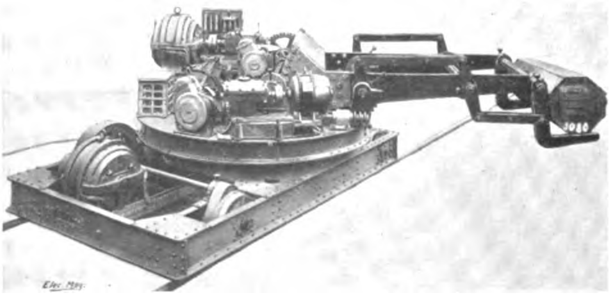


Fig. 7. Electric Block Conveying Carriage.

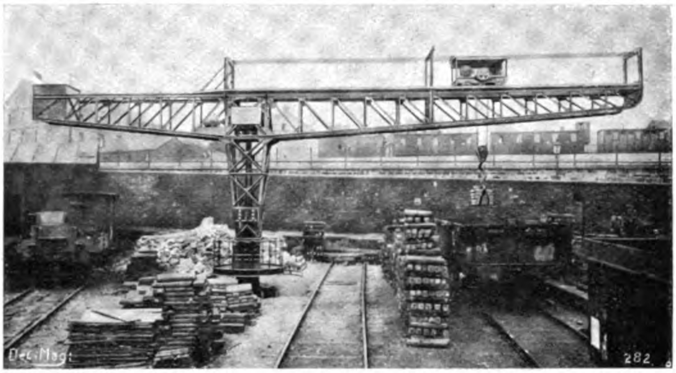


Fig. 8. Electric Revolving Post Crane.

for completely drawing back the angle arms out of the slits provided for the passage of the arms under the block. The travelling speed of the carriage is about 328 ft. per minute, and the jib carrying the block slews at the same speed.

Loading Cranes.

An example of a fixed loading crane is shown in Fig. 8. It is a detached revolving post crane of three tons capacity, the hook, at its maximum outreach, being 39 ft. 6 in. from the pivot. The framing revolves round a wrought steel pivot, which counteracts the overturning-momentum and transfers it to the foundation wall through the foundation plate. The movements of the crane are operated by separate reversible motors controlled from the round platform placed at the foot of the frame post. One important feature of this crane system is that the crane itself requires only a small ground space compared with the large area which it serves.

A loading bridge is shown in Fig. 9, resembling somewhat American designs. This bridge is used in the works of the Société Métallurgique Dnieprovienne at Kamenskoje for loading sectional iron. The crane is designed for a loading capacity of 3½ tons, and, differing from the usual American construction, is driven by separate three-phase motors working on a 190 volt circuit. The crane framing is a double-sided cantilever girder of about 289 ft. 6 in. in length, the supporting structures of which run on a track 26 ft. 3 in. gauge. This gauge is relatively small, but was necessary as the crane travelled across a bridge. The ground which can be covered by the crab is 282 ft. 2 in. in breadth. The clearance between the supports is 52 ft. 6 in., so that girders up to about 49 ft. 2 in. in length can pass between the supports to be conveyed to the loading tracks at the end of the crane bridge and to those between the supports. The crane is operated by two motors arranged parallel and placed upon the feet of the supports. The gears are coupled with each other by means of an adjusting transmission. The gears for lifting and crab travelling, together with their motors, are placed on the crab, the runway of which lies between the bridge girders. The hoisting mechanism is composed of a motor, worm and wheel, and two drums, which latter are 13 ft. 9½ in. distant from each other. The two blocks and their tackle are kept apart at an even distance by means of a distance-rail. The speeds of the crane are :—

	Per minute.
Lifting	39 ft. 4 in.
Crab traverse	295 „ 3 „
Speed of crane	237 „ 8 „

Goliath cranes of great span, especially for high travelling speeds, require considerable care in designing the framing, both with regard to the stiffness of the bridge in the horizontal plane, and in the arrangement of the crane-travelling gear. American constructors no longer rigidly connect the bridges of such cranes with the crane legs when the spans measure 100 ft. and more, but support the bridges at one end by a pendulum support running on one rail, and at the other end by a supporting frame running on two rails. The trestle of the loading crane shown in Fig. 10 is,

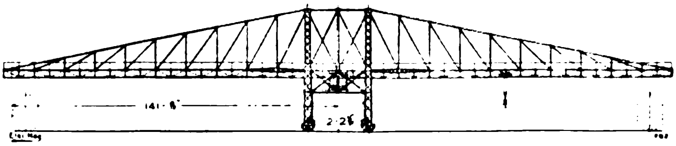


Fig. 9. Electric Bridge Loading Crane.

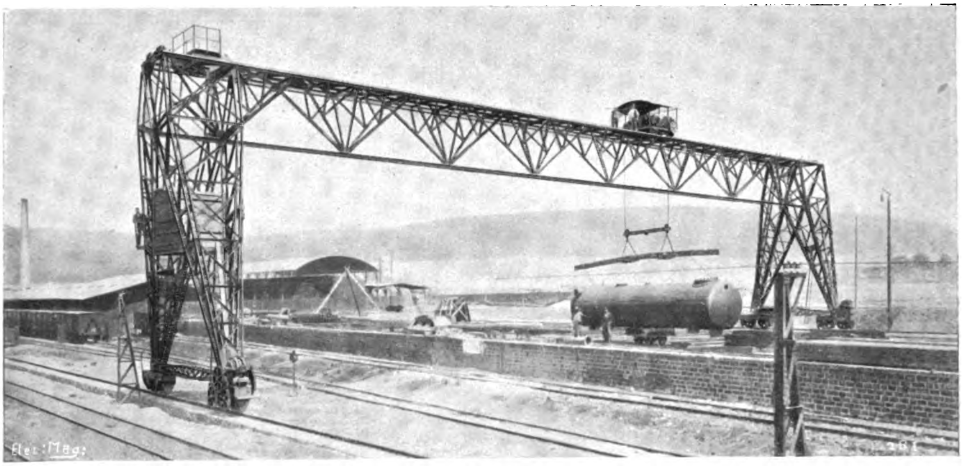


Fig. 10. Electric Goliath Crane.

however, constructed of rigid lattice work. It was built for the Roechling's Iron and Steel Works at Volklingen.

A remarkable feature of this crane is the manner in which a sufficient stiffness of the framing has been attained, considering the importance of reducing the total weight (crane and load) to be moved, as much as possible. For this purpose, the two load girders of the crane-bridge are placed in an oblique position to one another and fitted with a common joist; to stiffen the bridge in the horizontal plane a diagonal joist is divided between the two pressure-strappings.

The crane is worked by three-phase 400 volt motors, and high speeds are its characteristic feature.

	Per minute.
For Lifting	85 ft. 3 in.
Crab traverse	393 „ 0 „
Speed of crane	656 „ 0 „

The crab, which travels over the bridge, carries the hoisting gear, the crab travelling gear, and motors. Machine-cut spur wheels only are used in both gears. The load is carried by a two-rope tackle fixed to the drum which is grooved right and left. The ropes are guided over two sheaves along the sides of the bridge to the load block. The crab-traverse gear is fitted with an electromagnetic knee-lever-brake, which acts on all four running wheels. The crane frame is based upon eight wheels in pairs in bogie-frames under the four legs of the framing. At each end of the crane, a three-phase motor with two

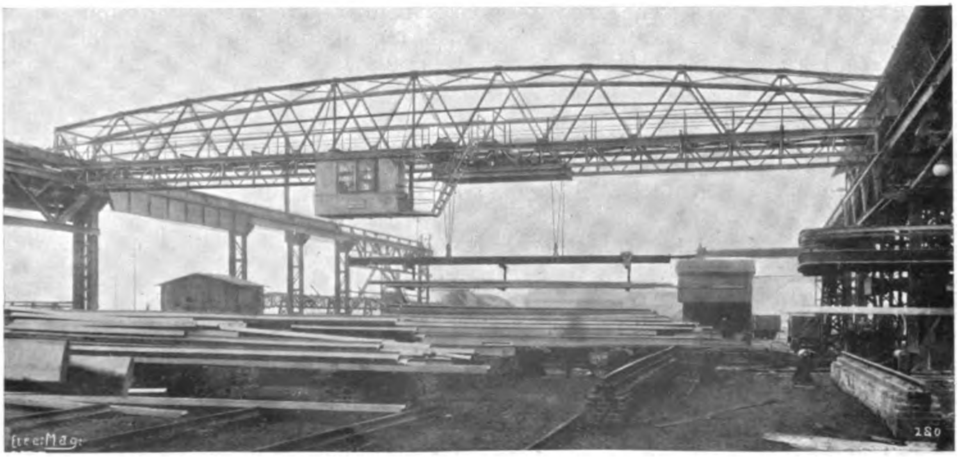


Fig. 11. 5 Ton Overhead Electric Crane.

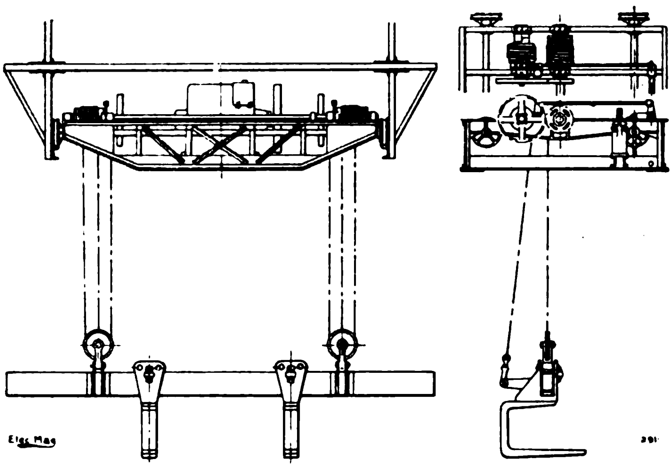


FIG. 12. DETAIL OF AUTOMATIC LIFTING ATTACHMENT.

wheel-gears is placed on one of the bogie frames which drives the respective pair of running wheels. The very powerful construction of the entire travelling mechanism ensures that, in spite of the great span and the high travelling speed, the crane always travels ***truly parallel.***

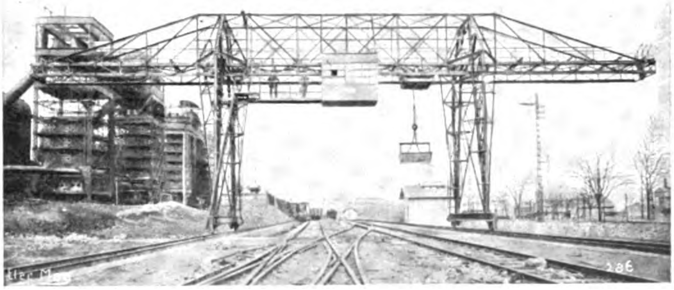


FIG. 13. 10 TON ELECTRIC LOADING CRANE.

The following designs of cranes will give some idea of a construction which aims at saving hands and of increasing the speed of loading by means of special modern arrangements.

Fig. 11 shows an overhead travelling crane of 5 tons lifting capacity, 103 ft. span, supplied to the Oberschlesische Eisenbahn - Bedarfs - Actien - Gesellschaft Friedensheutte O. S., which is arranged for automatically taking up and depositing its loads. The principle of this improved arrangement is illustrated in Fig. 12.

The shovel is carried by two ropes, one of which is usually a two-rope tackle, and one part of this is wound on a drum. A second drum contains the emptying rope. When simply lifting and lowering the load, it is worked through a gearing from the driven shaft of the first drum, so that both ropes have equal speeds of load. The second drum however, is not firmly connected with its shaft, but is free and is driven, when lifting, by a tappet of a socket-joint which is keyed on to this shaft. A ratchet-wheel is screwed to the drum and can be sustained by an electromagnetically worked pawl. If this be done, and the first drum be then moved in the direction of load lowering, the load-rope remains at rest, whereas the two-rope tackle descends by a certain distance, *i.e.*, until the other pulling side of the tappet strikes against the catch of the locked drum. The consequence is that the shovels assume a slanted position, and the load glides down from them.

The same arrangement of crab is used when goods in bulk, such as coke and ore, are to be handled by self-emptying buckets. Fig. 13 shows such a loading crane of 10 tons lifting capacity, which is used for emptying the buckets, previously filled from trucks by hand with ore or coke, into the bunkers in front of the blast furnace.

August Reichwald

* * *

This important subject, the application of electric power in steel works, will receive special attention in future issues of "The Electrical Magazine," at the hands of influential writers.

STEAM TURBINES FOR ELECTRIC GENERATING STATIONS.

By W. J. A. LONDON, A.M.I.M.E.

THE conservatism with which engineers adhere to a well tried and proved design has, no doubt, been the main reason why the steam turbine has only recently taken a prominent position amongst modern prime movers. Happily, however, facts and figures have lately been so extensively published, and exhaustive tests made by unbiased experts, that there can be little doubt left in the most prejudiced minds that the steam turbine can now hold its own against any other form of steam engine.

Its future success, and also the important part it is to play in the engineering world, is assured by the fact, that the best of our reciprocating engine builders are devoting their energies to this new field. The expiration of some of the important patent rights has widened the field for manufacture, and the present aspect goes to show that, in the immediate future, few tenders for steam engines will be submitted without an alternative for steam turbines.

Rapid strides are also being made on the Continent and in America. In fact, larger units have already been installed abroad than in this country. When Messrs. Parsons had made their record with a 500 K.W. unit, their American licencees were building a 1,500 K.W. unit; again, when the pioneer firm had reached 1,000 K.W. in one machine (ordered by a German Corporation), the first order received by their newly appointed Continental licencees was for a 3,000 K.W. unit.

In this article it is the author's intention to deal with the subject of steam turbines from a general standpoint. Few figures of tests are given, and the thermo-dynamics and theory barely dealt with. To do these subjects justice, each would afford sufficient matter for a long article in itself. So many tests have recently appeared in the technical press, that it is thought unnecessary to again retail this information. Those interested in the theory cannot do better than study the recent researches of the late Dr. Thurston, and Profs. Stodola and Reidler, and Mons. Rateau.

One of the most remarkable features of the present status of the steam turbine, is the fact that so many different principles are being worked upon, one and all, if we are to believe the figures published, giving precisely the same efficiency. The turbines of Parsons, Laval, Westinghouse, Stumpf, Rateau and others, all have their distinct characteristics, and in some cases, working upon principles as different as the water turbines of Jonval & Girard. The Laval turbine, with its one set of expanding nozzles and single wheel, is an example of a purely impulse turbine, whereas the Parsons type, with its series of contracted blades causing gradual drop of pressure, and subsequently slower velocity, follows the line of the Jonval hydraulic turbine. The principle of the Laval turbine necessitates an enormously high speed of rotation. The whole of the expansion of the steam takes place in the diverging nozzles, converting as nearly as possible the whole of the static pressure of the steam into kinetic energy, which is delivered up to the single row of blades on the rotating wheel. The steam acquires a velocity of something like 3,000 to 4,000 ft. per sec. The receiving buckets, to obtain maximum efficiency, should travel at about half this velocity, thus the high speeds of rotation in the Laval turbine of, say, 30,000 r.p.m., must mean the use of the finest material and workmanship. To utilise the power developed, gearing has had to be resorted to, and the speed of the shaft reduced about tenfold, before it could be directly applied to the driving of a dynamo. This use of gearing, and the fact that so far, the makers have not seen their way to increase the size of the turbine wheel, thereby reducing the speed of rotation, has limited the size of unit to about 300 h.p., and consequently the Laval turbine, although in itself a compact and ingenious machine, has as yet played little part in central station work.

The researches and experiments of Profs. Stumpf & Reidler on this type of turbine have shown, however, that wheels of larger diameter of sufficient strength can now be obtained to permit of a reasonably low rate of rotation, while maintaining the high peripheral velocity necessary for high economy.

In the Stumpf turbine, although the steam is completely expanded in the diverging nozzles, after leaving the single row of blades, it is carried once more back to the same row of blades, thereby expending all its energy on a wheel, with a slower peripheral velocity than half the absolute velocity of the steam. It must be remembered, that in the Laval turbine it is impossible to reach the theoretical wheel velocity for maximum efficiency, but in the Stumpf type, it is claimed that the whole of the available energy in the jet can be accounted for. This, however, still requires a very high velocity, and the makers state that, by a very careful analysis of the strains and stresses, wheels can now be made of, say, about 7 ft. in diameter, to run with a peripheral velocity of 1,200 ft. per sec., giving the sufficiently reasonable shaft speed of 3,000 r.p.m. for direct connection to the generator.

The Curtis turbine is a further example of the possible modification of the Laval principle, to suit the requirements of a direct connected set. nstead of trying to extract the whole of the energy of the steam in one wheel at high velocity, the Curtis principle is to compound the wheels, thereby reducing the wheel velocity. The steam leaves the first row of blades at high velocity, *i.e.*, only a portion of the energy has been transferred to the first wheel. The steam then flows through a set of guide blades, directing it on to the second set of moving blades. This operation can be repeated, until the steam flows from the last row parallel to the axis, with all its available energy converted into useful work. In general practice, two, three or four sets of nozzles with their corresponding rows of blades constitute the complete turbine. Another distinct departure has been made in this turbine, namely, its vertical construction. This question, however, is dealt with later.

The Parsons, the most well known and universally used of all present types of turbine, needs little in the way of general description, but too much credit cannot be given to the inventor for the way in which he has overcome the numerous difficulties met with, in the satisfactory design of a slow running turbine. His first machines, manufactured 20 years ago, received from those who used them the ominous title of "steam eater," but with dogged perseverance on the inventor's part, his turbine has lately reached an efficiency second to none of any steam engine in the world.

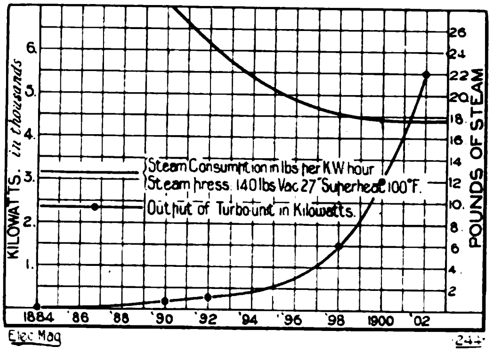


FIG. 1. CURVES OF STEAM CONSUMPTION AND INCREASE OF TURBO UNITS.

Fig. 1 illustrates graphically the reduction in steam consumption and the increase in the size of turbo units between 1884 and 1902.

By the gradual drop of pressure necessary for obtaining low velocities, a great number of rows or blades must be introduced, making the cylinder overall a considerable length, and to avoid fouling of blades, the most careful consideration must be given to the design. Again, a certain amount of length must be given to the dummy pistons for balancing the end thrust on the blades.

The Rateau turbine is similar to the Parsons, with the exception that the whole of the expansion between each row of blades takes place in the guide blades, which may be more correctly termed nozzles, the blades on the rotating part being similar to those in the Laval turbine, acting purely on the impulse principle. The advantage of this system is the elimination of any end thrust.

Fig. 2 shows the velocity diagrams of the various types of turbines.

Another distinct departure has recently been made by the Westinghouse Company,

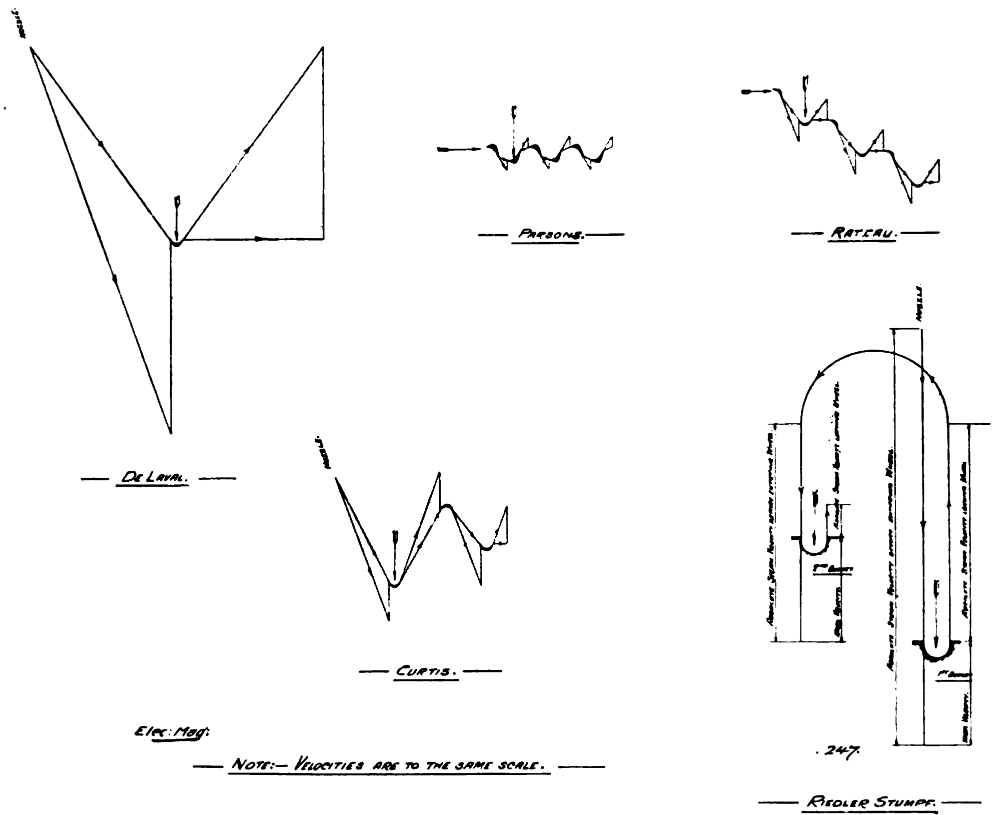


FIG. 2. VELOCITY DIAGRAMS OF VARIOUS TURBINES.

in their latest design of steam turbine. It consists of a combination of the two principles above mentioned. The idea being, whilst adhering to the well tried and efficient low pressure end of the Parsons machine, the hitherto long high pressure end, consisting as it does of so many rows of short blades, is substituted by an impulse wheel, thereby shortening the whole turbine. For large machines, of say, 1,500 K.W. and upwards, the design is such that the steam enters in the centre and flows both ways, thus relieving the spindle of any end thrust, and doing away with dummy rings and the subsequent loss introduced thereby. Even with the double flow type of machine, the whole length comes out shorter than the Parsons design. The diameter of the shaft being greatest midway between the bearings, makes a much stiffer construction of spindle permissible than is the case with the Parsons machine, where the smallest diameter is about the centre of the spindle. One interesting point about this new type, is the fact that the largest steam turbine unit yet ordered, is now in course of construction at the makers' works, eight of which are to be installed for generating the power necessary for the electrification of the London Underground Railways.

Considerable controversy has recently appeared in the technical press on the relative advantages of the steam turbine and reciprocating engines for electric power stations, the ball being set rolling by the publication of a paper read at Leeds, by Mr. W. H. Wilkinson, who, from actual experience with steam turbines in his station, advocates their superiority over the older type of engine. This, however, proved too much for one of the leading reciprocating engine builders, who lost no time in putting in his claim that the well-tried reciprocating engine could still show up several points ahead, both as regards efficiency, steam consumption, and general reliability.

The first stage of the discussion

promised to be highly interesting, especially when the turbine advocate proposed a comparative test between a machine of each type after two years of ordinary station working. But this challenge was unfortunately not accepted, the subject gradually developing into one of comparative station costs, a factor depending upon so many variables, that the paramount question of the engines themselves seems to have been left in the background. Instead of a comparison of station costs with reciprocating engines working with, perhaps, Babcock boilers, a poor condensing plant, and a load factor of 28·4, and another station with steam turbines with, say, Cornish boilers and a good condensing plant, and perhaps a load factor of 9·3, surely it would be more satisfactory, as recently pointed out in a discussion on this subject, if a heat account were made of each respective engine, irrespective of the surrounding variable conditions.

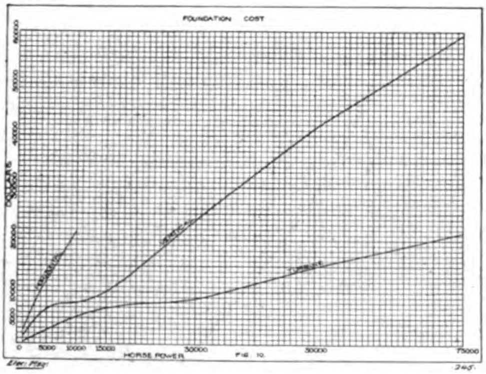


FIG. 3. COMPARATIVE COST OF FOUNDATIONS FOR VARIOUS PRIME MOVERS.

The question of comparative steam consumption seems always to be the principal basis for discussion in comparing the two machines, and rightly so, when one pound of steam per K.W. hour in a large station running regularly at a load of 30,000 K.W., may mean a saving of something like £5,000 per annum. But besides this the station engineer has other points to consider, such as first costs, floor space, cost of foundation. Then, later, there are the general working expenses, such as attendance, oil consumption, reliability, amount of spare gear to be carried, and many other points.

The question of floor space and cost of foundations was most fully gone into in a paper by Mr. E. H. Sniffen read before the American Street Railway Association, in October, 1902, and by his kind permission, one of the interesting curves he published, giving the comparative cost of foundations for various types of engines, is reproduced in Fig. 3.

One of the objections so often raised against the steam turbine is its apparent excessive length, but one has only to compare the dimensions with a slow speed horizontal set to see that not only is the turbine shorter, but it is only a fraction of the width as well. To cite an example: A 3,000 K.W. turbine in the Frankfurt Station is lying adjacent to a 1,000 K.W. slow speed engine set; the turbine being two or three feet shorter over all than the engine set, besides being considerably narrower. The turbine in question is of the two cylinder tandem type, making the machine longer by two bearings and a coupling than the more modern one cylinder type.

As mentioned above, one firm of turbine builders is now advocating the vertical construction, claiming thereby economy in floor space. This naturally appeals at first sight to the station engineer, when laying down a large number of units, but when superficial area of foundations is taken into account, it will be found that there is nothing gained over the modern shortened horizontal type, and, moreover, the difficulties of accessibility met with in vertical engines again present themselves.

The advantages of the steam turbine, with all its surfaces necessary for lubrication isolated from the steam cylinder, are already well known, but the saving in oil consumption in a large station by using turbines can become such a figure as to warrant consideration when comparing the two types of engines. From actual tests in England, on the Continent, and in America, the following figures are deduced:

	RECIPROCATING ENGINE.	STEAM TURBINE.	
Engine Oil	·00021 gals. p. k.w. hr.	·00005 gals. p. k.w. hr.	Mxd.
Cylinder Oil	·000183 ,, ,,	·000025 ,, ,,	
	·000393 ,, ,,	·000075 ,, ,,	

Now, taking the actual installation referred to above, namely: The London Underground Electric Railways, where eight 5,500 K.W. steam turbines are being installed, and assuming the price of oil at, say, 1s. 6d. per gallon average, we get the total consumption per year's working (averaging ¾ load):—Turbines, £1,462; reciprocating engines, £7,700.

The question of attendance needs little comment, it being clear to those understanding the running of large reciprocating engines that a machine requiring no attendance other than the occasional oiling of the few auxiliary parts, must mean a great saving in this respect.

"Is the steam turbine as reliable as the reciprocating engine?" is a question that the steam turbine contractors have so often to answer.

When it is considered that steam turbines are now running for operating the fans of lead works and collieries, where a shut down is only permissible once in six months, it would appear that their reliability is well established. Of course accidents do happen, such as blades stripping, necessitating a shut down, but leaving the generators and their troubles out of the question, this seems to be the only place where serious trouble has been experienced and could be anticipated. Experience in the design of the cylinder to prevent undue distortion when subjected to the temperature of highly superheated steam, and the construction and balance of the rotating part to prevent undue sagging or whipping, has so eliminated these troubles that, unless the machine is suddenly subjected to a much higher degree of superheat than the original clearance allowed for, or the foundations fall out of line, thus twisting the cylinder, there need be no fears on this score.

In both these cases, is it not likely that more damage would be done to a reciprocating engine subjected to the same unfair treatment? Again, this is further eliminated by a modified design with the length of cylinder and spindle reduced, and the diameter increased. With the system of forced lubrication now employed, the spindle is so kept out of actual contact with the bearing that the wear in the latter becomes negligible. An electric resistance of one megohm was recently measured between the running shaft of the turbine and its bearing, so that with a carefully designed machine for the actual working conditions, the possibility of stripping in a modern well constructed turbine should be entirely eliminated. Of course, there is always the risk of the oil pump breaking down, but this is common to all types of machines with forced lubrication. A gravity supply system, or a central oiling installation, as supplied to water power plants, and which in now being applied to large steam turbine installations, at once overcomes this danger.

The designers of the electrical end of the combined turbine set, to produce a satisfactory generator necessary for the direct connection to a turbine set, have not escaped without their difficulties. The design for such generators for certain given conditions of voltage and velocity when the speed has been limited to, say, 1,000 r.p.m. has introduced new factors, opening out quite a new field for research. In continuous current generators, commutation has been the main cause of trouble, and up to the present date it is still considered necessary to use metal brushes. In large machines, to reduce commutator troubles, Parsons apparently prefers two generators in tandem rather than make one generator for the full output. For alternating current, until within the last two or three years, the rotating armature was universally adopted, but the increasing demand for high voltages has rendered it necessary to adopt the rotating magnet field type.

Designing the rotating part with peripheral velocities of from 200 to 300 ft. per second, naturally introduced mechanical difficulties, firstly, as regards the stability of the material itself, and secondly, the satisfactory holding of the conductors and commutator segments. Further, the running balance difficulties are much greater in the generator than are possible in the turbine, as a generator with loose conductors can never be the same mechanical job as the solid turbine spindle. Experience has again taught many lessons, and the troubles originally met with of the conductors setting themselves after running, thus upsetting the running balance, has, by the adoption of more carefully designed and solid material, been successfully eliminated.

POWER: and·its·application·to· INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

* * *

Consumers of Electric Power.

By W. E. WARRILOW, A.M.I.E.E.

THERE was a time in the history of electrical affairs when power consumers, or rather would-be consumers, were at a loss to comprehend either the necessity for using electric power or the chief reasons why it should be taken advantage of. The majority of supply authorities were then busily engaged securing lighting customers, and not until assured of a good "peak" load did they endeavour to obtain power consumers, and thus flatten out what proved an undesirable feature in the daily output chart. Motors were also very scarce and controlling methods as crude, consequently after absorbing all the talk of advantages and economies in electric driving, the would-be consumer, though much enthused, found his dreams unrealisable.

Things have changed since then. The papers read before societies, once redolent with motor starter difficulties and motor troubles, are now full of comparative tests, which are fresh from the workshop, not the laboratory. Electricians have ceased to prattle about the advantages of electric driving. They assail the positions held by gas, steam, and oil engines with volleys of facts and figures, taking it for granted that the peculiar benefits derived by using electric motors need little further emphasis.

Manufacturers in their turn have standardized their apparatus, and both motors and starters of a common design, with readily comprehensible features, can be procured at short notice. Supply authorities hold out special inducements to power consumers, and in certain instances hire out motors. In other cases exhibitions ostensibly foster the cause of electric power, and practically demonstrate what can be done by it. We describe and illustrate in our Manufacturers' Section this month, a laudable attempt of this kind recently opened at Bournemouth. Further, the chief industries of the country, following the example taught by a wider experience abroad, are becoming more and more dependent on electric driving, and in such branches as printing, a speciality has been made of the motor and its controlling appliances. A few years only has brought about these changes, but there is still room for more consumers. Many are waiting for or disregarding the agency of electricity in their particular trade, because they either prefer to watch developments or think the energy impossible of adaptation to their particular sphere. A glance at the pages of this section this month should afford convincing evidence both of the manner in which electric power is being produced and also of its application to industry. As a specific instance the tanning trade may be mentioned.

The example quoted on p. 379 is typical of American methods, and the zeal of Americans to embrace the advantages of modern power agencies. There are many tanneries in this country in which the same economies, noted in this instance, can also be obtained, and where power is available it should certainly be introduced. Numerous other instances could be quoted, but the prospective consumer has now little excuse. At one time his requirements could not be met, but now all the information he desires is at his disposal, and what is more important, statements can be materially supported by the actual apparatus upon which they are based.

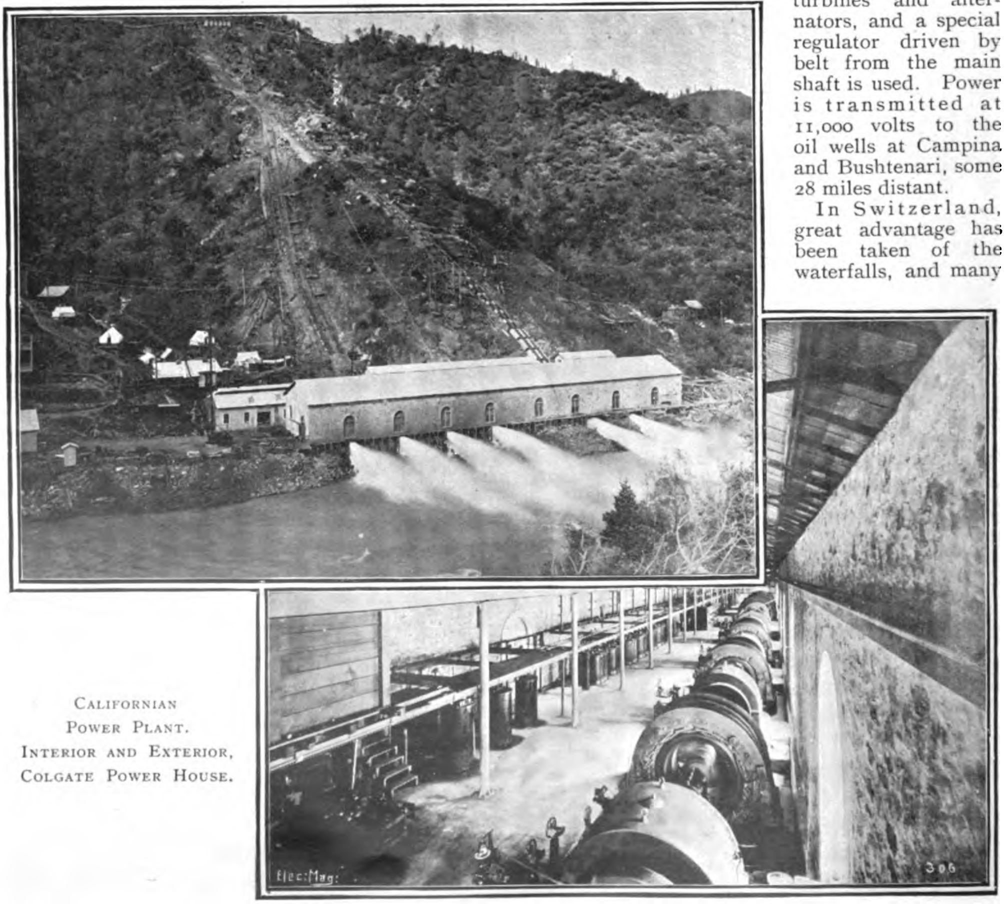
HYDRO-ELECTRICITY IN CALIFORNIA.

CALIFORNIA still maintains its reputation as the country of long distance transmission plants, and abounding as it does in natural water powers, its position is likely to remain unassailed for some time. Unlike the developments of such schemes as Niagara and the St. Lawrence, progress in Californian transmission work, has been fraught with enormous engineering difficulties. Bleak, wild, mountainous country has been crossed with lines whose voltage was far in excess of those attempted in less difficult areas. The Bay Counties and the Standard Electric Companies are the chief controlling interests in the State, having plant aggregating 25,000 and 15,000 h.p. respectively, though the latter company is building a new plant to develop 21,000 h.p. The Bay Counties Co. operates some 3,000 miles of transmission lines, the longest of these being 218 miles, from the Colgate power plant to Burlingame. The accompanying illustrations depict the interior and exterior of this station. The energy from most of the water power plants in the State is used extensively in the mining operations carried on. The value of electricity is fully recognised, and one mining company alone has contracted for 3,000 h.p. for its operations. The Sans Joaquin Valley Co. is transmitting energy some 32 miles and selling it at 2 cents per horse power hour. In the same valley, farmers have come to utilise electric power for driving their harvesting machinery, while an irrigation system has also been developed. Much capital is being laid down in schemes for transmitting hydro-electric power from the chief streams in the Sierras. One of these, which will develop 9,000 h.p., will be 4,500 ft. above sea level.

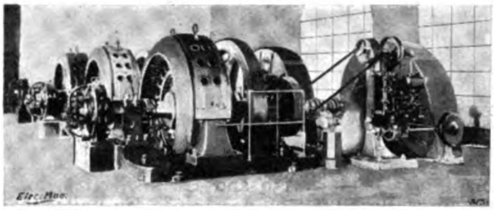
ROUMANIAN AND SWISS HYDRO-ELECTRIC PLANTS.

IN our last issue we incidentally mentioned in a small note, the power plant of Sinaia, Roumania, and promised an illustration of the same this month. The cut on opposite page gives an excellent idea of the power house, which contains three turbo-units of 1,050 K.W. capacity, each with its own exciter on the generator shaft. The power units are provided with an extra heavy flywheel between the turbines and alternators, and a special regulator driven by belt from the main shaft is used. Power is transmitted at 11,000 volts to the oil wells at Campina and Bushtenari, some 28 miles distant.

In Switzerland, great advantage has been taken of the waterfalls, and many



CALIFORNIAN POWER PLANT.
INTERIOR AND EXTERIOR, COLGATE POWER HOUSE.



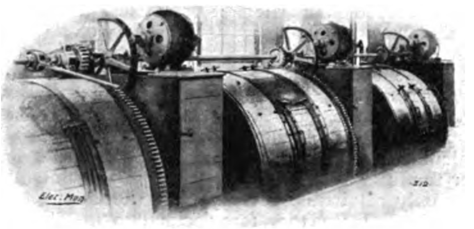
Sinaia Power Plant, Roumania.

unknown districts have sprung into commercial prominence by the introduction of hydro-electric power. The river Orbe, having its source in lake Joux, and flowing some distance underground, is used for power purposes, and steam, gas, and other engines have since disappeared as prime movers from the district. One large cement factory at Baulmes takes 300 h.p. alone. The La Clees Yverdon plant is equipped with six 300 h.p. turbines coupled to Oerlikon inductor alternators delivering 3 phase current at 5,300 volts 50 cycles. Both armature and field are stationary, the rotating portion of the machine being a cast steel cylinder, on whose circumference two laminated iron rings, made up of seven sections, are secured. 109 motors are connected to the mains, ranging from 1/10 h.p. to 130 h.p., the total power being 612 h.p. The secondary mains supply 8,473 incandescents and 74 arcs, the total candle power being equal to over a million. The charges are, per 10, 16, or 25 c.p. lamp, 9, 14, and 19 francs respectively for 400 hours per year, and for 800 hours 12, 19, and 24 francs. The power rates vary from 24 francs per h.p. for 1/2 h.p. to 15 francs per h.p. for 30 h.p. The Les Clees Yverdon plant is operated continuously, except for daily stops of one hour at 12 to 1 p.m., and 5 hours on Sundays, 9 a.m. to 2 p.m.

◆

IMPORTANT TO BRITISH TANNERS.

The continued use of electricity in this country should not escape the notice of those engaged in the tanning trade. The lay-out of tannery buildings makes it difficult to concentrate the power required, consequently isolated units are needed, and unless economical transmission is employed the loss can reach an alarming figure. We commented, in a short note last month, on the use of electric power in a Milwaukee tannery, and are now able to illustrate a battery of tan drums driven by separate motors as used in this plant. These motors can be reversed in a moment at the will of the operator, and are under complete control. Motors have been applied to every machine in the works, either individually or on the group system. Rollers, glossing machines, pebbling jacks, tan drums, bate wheels, and fleshing machines, grouped in separate buildings, have their own motors supplied from a central power source. The loss through imperfect splitting is reduced by the motor drive by 90%, and the daily output is materially increased. The motor driven fleshing machine saves 50% over a belt driven unit, while the output is increased by 30%. The machine in this case is direct coupled to the motor, which, being under perfect control, can be immediately stopped by the operator and the feed regulated if required. Shoddy and sole leather rollers are also important machines in which much time and expense is saved by electric driving. The boomer press is used in a portable form in the Milwaukee tannery, and is operated by an overhead motor, the whole running on a floor track. With the steam boomer press the hides had to be carted to the press. Among other advantages the ease with which extensions can be carried out in an electrically driven plant should commend the method to the notice of all tanners. It must not be thought that any special motor is required, consequently the conversion to the electric drive could be conducted quite economically, and the initial outlay would soon be offset by reduction in working cost and increased output. The plant we have briefly referred to was recently depicted in detail by the *Electrical Review*, N.Y.

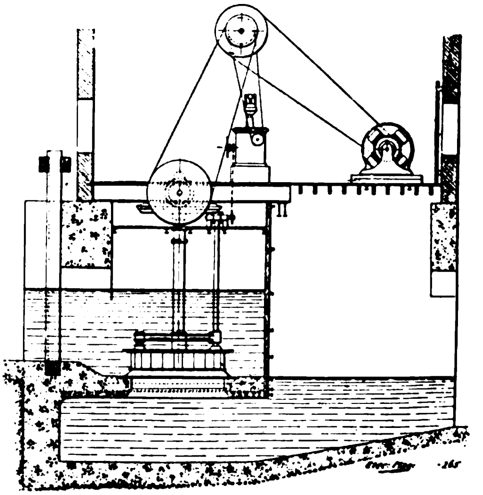


Motors Driving Tan Drums.

◆

A SMALL BRITISH WATER POWER PLANT.

We referred last month to the utilisation of water power in this country, and coupled the name of Mr. A. Steiger, M.I.C.E., with our remarks. We abstract from *Engineering* a description of water power plant installed through his agency on the river Newry, for supplying electrical energy to the works of Messrs. W. & G. Moorhead in that town. The site of the turbine house is an old dam



Newry Water Power Plant.

which diverted a portion of the river into a mill race a quarter mile long, for the supply of a water wheel. The site at the dam was preferred to that at the end of the race, as, in spite of the slight increase of fall from point to point of the river, the loss in the race through friction quite offset any advantage which might be gained. Careful calculation showed that the maximum horse power for the full weir length (167 ft.) was 354, but this was only attainable at very heavy floods of short duration. It was therefore decided to instal a 50 h.p. wheel and operate a 30 K.W. dynamo from it. This allowed for a loss of 10% in gearing between turbine and dynamo. The turbine is a central flow type with vertical shaft running at 55 r.p.m., and gearing by bevel wheels into a horizontal shaft revolving at three times the speed. Belted to this is a horizontal overhead shaft driven at 300 revs., and from this the dynamo is operated by belt at 650 revs. Arc and incandescent lamps, and also motors, are supplied at the works by an overhead line, quarter mile long. Automatic regulation is effected by a pressure apparatus, comprising two rotary oil pumps driven by belts from the turbine shaft. The circulation of this oil is controlled by a pendulum governor which makes one or other of the pumps effective in moving the guide vanes of the turbine, through the medium of a worm and sector. The vanes are balanced and quickly adjusted to a new position by the governor under changes of load.

~

THE COST OF ELECTRIC POWER.

The desirability and necessity of introducing electric power are now generally recognised, but reliable data is really needed to persuade power users into adopting electric driving. In some cases an isolated plant is needed, and figures are useful to indicate the cost of generating power under such conditions. Mr. E. J. Fox, in a paper before the Cleveland Institute of Engineers, recently presented some interesting tables compiled from tests made on small private plants. We reproduce herewith Table I. particularizing a 500 K.W. plant in two 250 K.W. units, driven by Willan's triple expansion engines at 250 lb. pressure, and on a vacuum of 25 in. The average cost per unit for a month run was ·337d. per unit. From figures prepared by Messrs. Dorman and Long, Middlesbrough, whose plant totals 1,500 K.W., with 60,403 units generated per week, and a coal bill of 3·04 lb. per unit, the total costs reached ·401d. per unit. At Messrs. Crompton and Co.'s works, Chelmsford, which may be taken as typical of a manufacturing works, with 420 K.W. plant in 3 units of 150 and 120 K.W. sizes, and a half-yearly output of nearly 600,000 units, the total works costs were ·579d. per unit. The feed pumps in this case are motor driven. The cost of coal per unit was ·43d. The City and South London Railway works costs, which may be inserted by way of comparison, were ·446d. per unit for twelve months' working, the average weekly output being 132,195 units. At Crewe works, with a yearly output of 430,000 units, the average works costs were ·525d. per unit.

TABLE I.—*Watson Bros., Linwood, 500 Kilowatt Plant Readings for Consecutive Weeks in June, 1903.*

Units generated per kilowatt installed, taking 50 weeks a year.	Units generated per week.	Total coal per week.		Cost of coal		Lbs. coal per unit.	Coal in pence per unit.			
				Per ton.	Per unit		Oil waste, stores.	Wages.	2½ per cent on £10,000 repairs.	Works costs.
		tons	cwt	s. d.	d.		d.	d.	d.	d.
6,400	64,000	93	3	8 0	·138	3¼	·011	·018	·018	·185
5,700	57,090	93	8	8 0	·152	3⅔	·012	·021	·021	·207
4,419	44,190	81	12	7 9	·171	4	·016	·027	·027	·242
5,088	50,880	71	15	7 9	·131	3⅒	·014	·023	·023	·191

A paper, read by Mr. B. Longbottom before the Manchester Association of Engineers, on the adaptability of electric driving, also contains some valuable data, which should afford convincing evidence of the value of the electric drive. From figures comparing mechanical and electrical driving, the loss in transmission with the former is placed at 65%, with power varying from 30 to 900 h.p. on load. A useful table, giving the combined efficiencies of engines and dynamos, was given, which we reproduce herewith:

TABLE II.

SIZE.			Engine Efficiency.			Dynamo Efficiency			Combined Efficiency.		
I.H.P.	Engine	R.P.M.	Load.			Load.			Load.		
			Full	¾	½	Full	¾	½	Full	¾	½
25	Compound	500	92	90	86	87	85	80	80	76½	69
50	,,	700	93	91	87	89	88	84	83	80	73
100	,,	550	92½	90½	86	91	90	87	84	81½	75
250	,,	500	93	91	87	93	92	89	86½	83½	77½
500	,,	375	93	91	87	94	93	92	87½	84½	80
1000	,,	250	92½	90½	86	95	94	93	88	85	80
1000	Triple Expansion.	300	91	89	84	95	94	93	86½	83½	78

TABLE III.—*Fuel cost of Electrical Energy. Slow Speed Horizontal and Vertical Condensing Engines. Direct-coupled.*

I.H.P. of Engine.	* Cost of Coal per Hour, Pence.			Output of Generator Kilowatts.			Cost of Current per B.T.U., Pence.		
	Full	¾	½	Full	¾	½	Full	¾	½
25	2·9	2·5	1·8	14·7	10·6	6·4	·197	·236	·282
50	5·6	4·8	3·5	30	22	13·2	·187	·218	·265
100	10·3	8·9	6·7	60·5	43·5	26	·17	·204	·258
250	25	21·7	16·3	155	110	68	·162	·197	·24
500	48	42	32	308	218	130	·156	·193	·246
1000	92	81	61	620	440	265	·148	·184	·23

* Coal at 10s. per ton.
Steam pressure 150lbs. per square inch.

In considering various examples, ¾ load is taken as the average working condition, this being more easily realised in practice. Taking a group of motors from 1 to 100 b.h.p., and the average of these as 7½ b.h.p., an efficiency of 83% was possible. The frictional loss in well arranged group driving might be taken as ranging between 10 and 25%. Tables giving the fuel cost of electrical energy with various engines were appended to the paper, and they are given herewith in abridged form.

TABLE IV.—*High-speed Vertical Condensing Engines. Direct-coupled.*

I.H.P. of Engine.	* Cost of Coal per Hour, Pence.			Output of Generator in K.W.			Cost of Curren per B.T.U.		
	Full	¾	½	Full	¾	½	Full	¾	½
25	4	3·1	2·2	15	10·7	6·4	·266	·29	·344
50	7·5	5·9	4·1	31	22·4	13·6	·242	·263	·3
100	14·5	11·2	7·9	62·5	45·5	28	·232	·246	·282
250	33	25·5	18	161	107	72	·205	·238	·25
500	63	48·5	34·5	326	236	149	·193	·214	·232
1000	133	95	67	655	475	298	·203	·2	·225
1000	103·5	80·5	57·5	645	467	290	·161	·172	·198

* Coal at 10s. per ton.
Steam pressure, 150 lbs. per square inch.

TABLE V.—*Gas Engines. Direct-coupled.*

I.H.P. of Engine.	Cost per B.T.U. in Pence.								
	*Town Gas.			† Dowson Gas. Anthracite Coal.			§ Mond Gas. Bituminous Coal		
	Full	¾	½	Full	¾	½	Full	¾	½
30	·6	·63	·74	·238	·252	·295	·057	·06	·071
45	·55	·59	·69	·221	·236	·276	·053	·057	·066
90	·53	·56	·64	·21	·224	·257	·05	·054	·062
175	·51	·54	·62	·204	·218	·248	·049	·052	·059
500				·177	·188	·216	·042	·045	·052
1000				·174	·185	·213	·042	·044	·051

Basis.—* Gas at 2s. per 1,000. † Coal at 25s. per ton.
§ Coal at 6s. per ton.

GENERAL POWER NOTES

Power at Fort Frances, Canada.

From the *Canadian Manufacturer* we learn that an agreement has been come to between the Ontario Government and a syndicate owning power plant on the American side of the Rainey River at Fort Frances. The latter, it is decided, shall develop the full dam capacity for power, but render one half permanently available on the Canadian side. No higher charge for power is to be made on the Canadian side than on the American side, and the town of Fort Frances is to be supplied on favourable terms. From reports of the late engineer of Public Works, the horse power available is equal to 16,000, of which 8,000 will be available on the Canadian side.

Wind-Motors.

Modern steel wind turbines for generating electricity were the subject of a lecture recently delivered before the Leipzig Electrical Society, by Mr. R. Brauns. Reference was made to the wind motor of the Deutsche Winterbinen Werke, Dresden, which was fitted with a special regulating arrangement, ensuring uniform speed and entire safety during storm. An adjustment of the vanes bringing them parallel to the action of the wind brought about this regularity of speed. An automatic switch was needed to insert the dynamo with the accumulators or outside circuit. It was stated that the dynamo could be run successfully with a wind velocity of 40 ft. per second.

A 20,000 Volt Transmission Plant.

At Lebung, Austria, a 20,000 volt plant is in operation on the river Mur, one of the chief rapids of which furnishes the necessary water. An article in *Engineering* recently gave some details of the plant, which we gather comprises four turbines aggregating 3,000 h.p. The generators have revolving fields, which could not be built of sufficient weight to ensure regularity in speed, consequently a fly-wheel was added. Step-up transformers of 650 K.W. capacity, air cooled, and of the single-phase type, with the mesh connection, are used to raise the generator pressure from 1,500 to 20,000 volts. Singularly enough, air break switches controlled by a fuse are employed on the E.H.T. lines. Special care has been taken in designing the transmission lines, which were subjected, successfully, to a test pressure of 24,000 volts. There are three sub-stations in which the line voltage is lowered to 500 by oil transformers. The plant has worked without hitch from the start, despite numerous heavy falls of snow in the district.

The American River Company's Plant.

The water power plant of this company supplies Placerville, Stockton, and Folsom, situated four, eighty, and thirty miles respectively from the power house. The dam is seven miles above the station, which is fed with water by a flume, planked four feet high. A ditch supplied with water from two creeks can keep the wheels going during the winter and permit repairs to be done to the flume or dam. Two three-phase generators, each of 1,500 K.W. output, are driven by Belton wheels of 3,000 h.p., controlled by Lombard governors, which have an attachment for operation from the switchboard. The height of the water in the penstock is indicated by an ammeter and an adjustable induction coil. Seven transformers, each 625 K.W., can raise the pressure generated from 2,000 to 60,000, 50,000, 40,000, or 30,000 volts. They are oil insulated, water cooled, and provided with an automatic attachment for discharging the oil outside the power house in case of fire. Air break switches of the fuse type are used on the E.H.T. circuits. A seven strand aluminium conductor on poles 180 ft. apart, constitutes the transmission line.

Power from Glacial Streams.

THE glacial and mountain streams of the Alpine regions of France are being turned to good account, and districts hitherto commercially insignificant are now becoming prosperous and important. In Isere some 75,000 h.p. of hydro-electric plant is in operation, while the water power directly used has risen from 20,000 in 1880 to 140,000 in 1900. Grenoble will shortly be supplied with power and light from a station in the Romanche Valley, 27 miles distant, and is now laying its cables in readiness.

Power Discussions before the A.I.E.E.

A number of important papers have been read at the two recent meetings of the American Institute. Mr. Semenza, dealing with European transmission line practice, emphasised the importance of the line as an engineering feature of the undertaking. As great calculation and care were necessary as with the apparently more important prime movers and their generators. European lines are built across country, and not alongside roads, the extra cost of right-of-way being quite outbalanced by the shorter line. Experience indicated that iron poles were preferable to wood, in that their life was much longer and the spans could also be increased. But 16 iron poles were needed to 53 of wood, the cost being £205 and £195 respectively. The weight of iron poles needed careful calculation, the author quoting an instance of 200lbs. excess per pole, or a total of about 60 tons in a line of 600 poles, built without much precaution. Glass insulators were not used in Europe, porcelain being superior on account of its glazing. Comparing oil and air blast transformers Mr. E. W. Rice, junr., pointed to the fire risk incurred with both types. In the former the starting of a fire amid such a quantity of inflammable material exposed to a large volume of air, would be followed by rapid combustion ; with the latter type, internal arcing was quickly quenched, but the oil might be ignited by discharges at the surface of the oil. If transformers were completely isolated in a separate building, the fire risk to surrounding plant was practically eliminated. Group switches in large plants was the subject of Mr. L. B. Stillwell's paper, in which arguments for and against the use of oil switches for sectionizing bus bars were advanced. Mr. E. M. Hewlitt spoke in favour of the oil switch, his reasons being no new addition to present knowledge. Terminals and bushings for H.T. transformers were the subject of a paper by Mr. W. S. Moody, the author imparting valuable data on an important item in power plant design. With main terminals for pressures below 40,000 volts, the insulation presented little difficulty, but above this limit troubles were experienced. Up to 160,000 volts the author recommended varnished wrappings next the lead, this to be brought through a porcelain bushing, both wrappings and porcelain to be respectively equal to half of the test pressure to be applied. The leads to be equal to the working pressure and the porcelain to provide the necessary factor of safety. The author also described a special terminal, which had successfully withstood a pressure of 375,000 volts, such a pressure being suitable for testing purposes.

HOME POWER NOTES.

Fife Power Company. A site for the plant of this company has been decided upon between the Town Lock and the West of Fife Mineral Railway. Building will shortly be commenced.

Jute Works. The jute works of Messrs. Cox, Lochee, Dundee, have recently adopted electric driving, and J. Scott & Sons, of the same place, have decided to take a similar step. Gas driven dynamos will be used, and it is expected that other firms in the district will follow this good example.

Gas and Electricity at Honley, Yorks. A "baby" electricity plant was recently opened at Honley, Yorks, where a 35 b.h.p. gas engine and dynamo has been installed at the gas works. The mains are bare copper wires on steel poles, supply being given at 200 volts. The plant has a capacity of 2,500 8 c.p. lamps.

Sunderland Power Supply. The Sunderland Corporation has two good power consumers in the North Eastern Marine Engineering Co. and Messrs. William & Doxford's shipyard. The former is supplied from a special sub-station containing three 300 K.W. transformers; 22 motors aggregating 520 h.p. are to be installed, and the consumption is expected to be 600,000 to 800,000 units per annum. The latter installation comprises 23 motors of 445 h.p., but the corporation contract is based on a total of 1,892 h.p. A portion of these motors are supplied from the company's own plant. An article in a recent issue of *The Electrician* gave some valuable details of the plant.

POWER NEWS FROM ABROAD.

A Generous Offer. The Sanitary District Trustees of Chicago have recently offered that city the surplus power which will be developed at Lockport, Ill., by the waters of the sanitary canal, "at a rental sufficient only to defray the necessary running expenses of the plant."

Gas and Electricity at Beirut. The Beirut Gas Works have recently been purchased by a wealthy Syrian, Ibrahim Sabbag, who intends to develop the powers vested in the company for the supply of electricity. Mr. Sabbag hopes to extend the use of electricity throughout Turkey-in-Asia.

A Mexican Gas Plant. The Montezuma Copper Co., Nacozari, Mexico, have a power station containing eight gas driven generators, furnishing power and light throughout its works. Producer gas is used and the generators are all run in parallel. A novel feature of the plant is the extraction of gas from wood, full details of the process being given in the March number of *Electro-Chemical Industies.*

Idaho Power Plant. A power station to develop, ultimately, 25,000 h.p. will shortly be laid down at the mouth of the Grand Ronde River, whence energy will be delivered to Moscow, Genesee, and other towns at 20,000 volts three-phase. Current will be furnished 24 hours per day, and operations starting in April are expected to be completed by July. The city authorities at Moscow anticipate a saving of 25 per cent. in pumping water, over the present steam plant.

Passing of the Main Belt. *The Electrical Review*, N.Y., in a recent leader, says "The manufacturing Mahomet must go to the power mountain, whether it be that of the water-wheel or steam engine. The first sites for manufacturing were necessarily at the locations where water power was developed. The introduction of electricity has changed this necessity of the close physical relation between prime mover and machine. It is providing for the delivery of power wherever it may be required, particularly in connection with artisans in cities using small amounts of power."

Californian Electric Gold Dredgers. As we remarked in a previous note in this issue, electricity is much used for driving gold dredgers in California. Steam power was prohibitive, but with cheap electricity dredging ground averaging less than 10 cents per yard was profitable. Endless chain buckets are usually driven by motors supplied by cables from the shore. A standard three-phase low voltage is sometimes used, but H.T. currents of 4,000 volts are frequently supplied to transformers on the dredger. Not unfrequently the transformers are placed on a pole near the boat. Some 40 electric dredgers are now in operation.

A Motor Driven Coin Counter. A recent issue of *The Electrical World* contained an account of a coin counting and wrapping machine driven by a small motor. The machine counts and wraps at the rate of seven coins per second, or 420 coins (8—12 bundles) per minute. The speed is limited only by the examination of the coins by the operator. The motor consumes but $\frac{1}{10}$th amp. on a 110 volt circuit, and can be connected to a wall socket. The machine is the invention of a man originally connected with a penny-in-the-slot company who gained his living by the returns of such machines, and had most of his revenue in coin which needed laborious hand counting.

The extraordinary and rapid developments in electric traction call for a special section entirely devoted to this work. The main systems in vogue or projected in every country will be specifically considered. and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

ELECTRIC TRACTION FOR RAILWAYS.

IV. The Arnold Electro-Pneumatic System.

By W. M. MORDEY, M.Inst.C.E., M.I.E.E.

(Continued from page 269).

More or less definite reports have appeared from time to time of a novel system of alternate current railway traction which was being worked out by Mr. B. J. Arnold, an American engineer, of whose standing and competence it is only necessary to say that he is, at the present time, President of the American Institute of Electrical Engineers.

It appears that Mr. Arnold, who has advocated the application of alternate currents to railway working for some time, has been engaged in developing a method which has some features of great interest. Put very briefly, this method consists in combining a compressed air system with the train motors, charging suitable reservoirs with compressed air when there is a reserve of power available, and using the energy so stored to supplement the power developed by the train motors when additional power is needed.

This method has some very attractive features. It enables a train to become temporarily independent of a supply of electrical energy; it provides a means of storing energy when running down hill, or when braking, and of making use of that stored energy to help at other times; it offers a prospect of reducing the size and cost of the generating station, by lessening the irregularities of the load—that is, by lowering the peaks and raising the hollows of the load curve—and it makes it possible to use electric motors designed for the average power rather than for the maximum power.

It was Mr. Arnold's hope that, before now, he would have demonstrated, by actual trials, that these good features could be realised in practice, but a regrettable accident has made that impossible for the present.

After some preliminary trials with an experimental locomotive, arrangements were made by Mr. Arnold for demonstrating the system on a railway between Lansing and St. Louis, Michigan. A new locomotive, embodying the results of Mr. Arnold's experiments, was built, and on Dec. 17th last, it was finally got into proper working condition, and equipped with the necessary testing instruments ready for

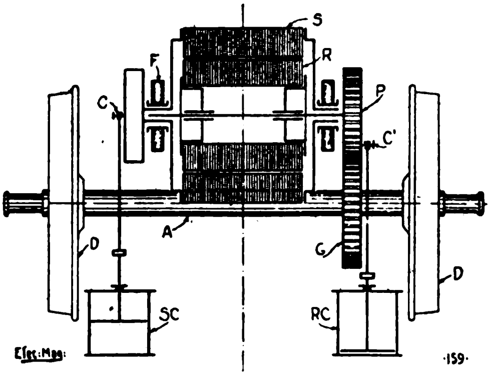


FIG. 1. DIAGRAM OF ARNOLD'S ELECTRO-PNEUMATIC MOTOR.

R.—Rotor.
S.—Stator.
F.—Frame.
P.—Pinion on rotor.
G.—Gear on car shaft.
A.—Car shaft.
D.—Car driving wheel.
R.C.—Rotor cylinder.
S.C.—Stator cylinder.
C.—Crank of stator.
C1.—Crank of rotor.

actual trials. The next morning it was destroyed by fire, together with the car shed containing it, as well as two new cars built for the trial.

Mr. Arnold is to be condoled with on this misfortune, which necessarily puts off for a considerable time a practical trial of the system. He has therefore thought it best to give some account of his work as far as he has carried it,* in order that those who are interested in electric railways may know the direction in which he is working, and be enabled to weigh his system in comparison with others that are now being put forward for consideration. It is understood that he is making fresh preparations for practical trials, which he promises to describe at a later date before the American Institute of Electrical Engineers.

Although this system is capable of being used with three-phase motors, or with direct currents, Mr. Arnold has fully recognised the advantages of one-phase working, and his experiments have been directed to employing that method.

Fig. 1 diagrammatically illustrates the system, or rather one form of the system. R is the rotor of a one-phase synchronous motor, geared to the axle of the car. By means of a crank pin (C_1) secured to the pinion (P), the rotor (R) is also arranged to drive the air compressor cylinder (RC). The stator (S) of the induction motor is mounted so as to be capable of rotating round the rotor (R), and is provided with a crank pin (C) arranged to drive the compressor cylinder (SC). Both the cylinders are connected to air-reservoirs (not shown in the diagram) and are provided with suitable valves, controlled from the driving platform by a single controller, by which the speed and power of the car can be controlled by the air cylinders, it being stated that no other regulating devices are necessary.

By this control, each compressor may either compress air into the tanks, or may be driven by compressed air from the tanks. A rotary or turbine type of air engine may be used instead of the reciprocating type indicated in the diagram.

It will be seen that, like the Ward-Leonard motor-generator system, this arrangement of Mr. Arnold does not require a motor having a large starting torque; any motor capable of starting from rest would do, and apparently the intention has been to use a synchronous motor, keeping it going so long as the locomotive was in service.

The disadvantage of having to keep the motor going even when the train is at rest is not a very serious matter, and may easily be made up for by economies which it makes possible, especially on lines where the runs are short and the startings and stoppings are numerous.

We have all of us come across an arrangement patented or proposed many times for making the armature of a dynamo run one way, and the field magnet the other, so reducing the apparent speed of the machine—a laudable object

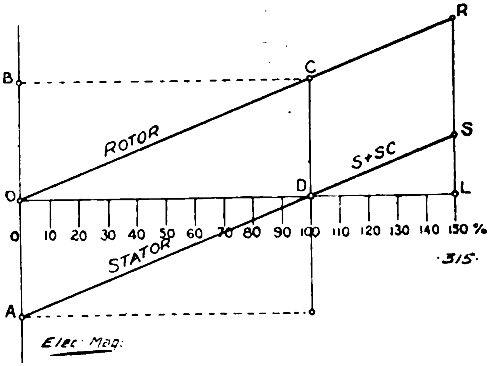


FIG. 2. DIAGRAM OF ROTOR AND STATOR SPEEDS.

---

* *The Street Railway Journal*, Vol. XXIII., No. 1, Jan 2nd, 1904.

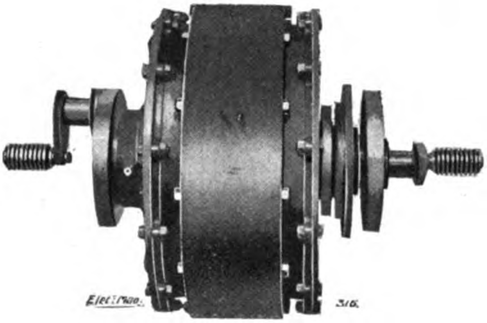


Fig. 3. Arnold Electro-Pneumatic Motor.
Outside view, showing Cranks.

which, however, can usually be achieved more easily and cheaply by making the machine larger and retaining its simplicity. Mr. Arnold adopts this arrangement, but for a different and original purpose—he uses it as a means of varying the speed of his train, for starting, accelerating, braking, and stopping, without change of speed of his motor and without the use of regulating resistances. He illustrates the working of this device by a diagram (Fig. 2) in which the horizontal line ODL represents the train speeds as percentages of the synchronous motor speed, while the vertical values above or below ODL represent the relative "rotor" and "stator" speeds corresponding to the train speeds shown.*

The motor being synchronous, and the "stator" and "rotor" both capable of rotation, the relative velocity between them is constant—their respective speeds being represented by the vertical distance between the two parallel lines ADS and OCR. As the driving wheels D are positively geared to the "rotor" by the wheel G and pinion P, the "rotor" stands still (at point O on the diagram) when the train is at rest. This is ensured by throttling the outlet pipe from the compressor cylinder RC, so making it impossible for the "rotor" to revolve. The relative speed of "rotor" and "stator" being fixed by the condition of synchronism, the "stator" will run at full synchronous speed OA when the "rotor" is at rest. The whole power exerted by the motor when the train is at rest is thus developed by the "stator," and is utilised to drive the compressor SC, and so to store energy in the air reservoirs.

By admitting compressed air from SC, or from the reservoirs, to RC, the "rotor" is made to start, and the train with it; and as it accelerates, the "stator" slows down until the train gets up to full speed, when the "stator" will come to rest. This arrangement forms a variable-ratio speed gear, combined with a means of storing compressed air, the ratio covering the full range of the speed of the train—the motor (considered as a whole) running at one speed the whole time. But the speed limit of the train is not restricted to that corresponding to synchronous running of the motor.

Mr. Arnold claims that it is even possible to run the motor above synchronous speed by reversing the direction of the air by means of the controller. By using the store of compressed air acting on the cylinder SC, to drive the "stator," a still higher speed can be attained. This condition is represented by the part of the diagram to the right of the line DC, where the "stator" is driven at a speed indicated by the distance LS, the total effective speed of the motor being thus increased from RS to RL, and the train speed correspondingly raised.

This is ingenious and interesting, but it may be questioned whether Mr. Arnold does not keep too exclusively in mind, the storing of spare energy by his compressed-air arrangement—he does not point out that if he used a non-synchronous induction motor it would be possible to return energy electrically to the line above

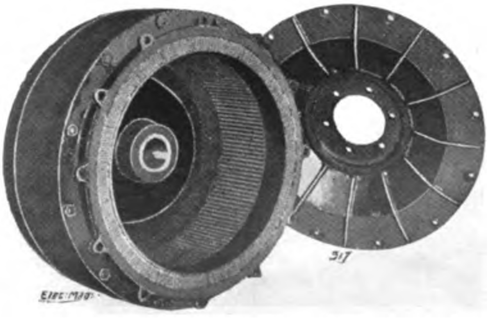


Fig. 4. Arnold Electro-Pneumatic Motor.
Stator with end cover removed.

---

* Mr. Arnold can hardly be blamed for using the words "rotor" and "stator" without reference to their literal meaning.

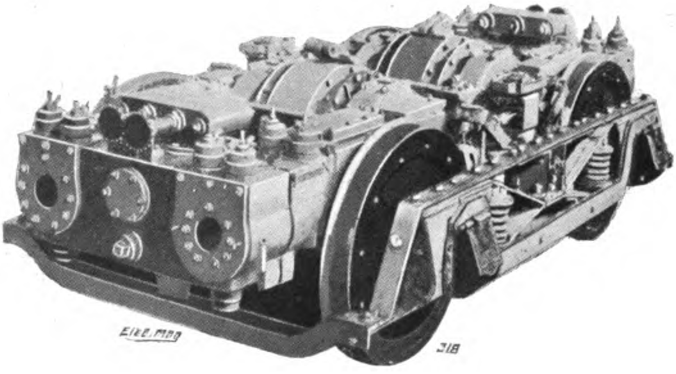


FIG. 5. ARNOLD ELECTRO-PNEUMATIC MOTOR.
Complete Locomotive Track.

synchronous speed, nor that with a synchronous motor energy could be returned to the line at synchronous speed —that is, at any speed of the train— by raising the excitation—or even with fixed excitation. Conditions may easily be met with under which the surplus energy may usefully be sent to the line to help the generating station. Such a use of the apparatus could hardly fail to be more economical than the use of compressed-air process alone, and it would have the advantage of not being limited in usefulness by the capacity of the reservoirs.

The construction of Mr. Arnold's motor will be understood from Figs. 3 and 4. The former is an outside view of the motor, showing the two cranks—one on the "rotor," the other on the "stator." Fig. 4 is a view of the "stator" with the end cover removed, showing the space in which the "rotor" moves. Apparently this motor is a non-synchronous "squirrel-cage" induction motor. Although the action is explained by the inventor, by reference to a synchronous motor, a certain amount of slip would be no disadvantage. Certainly a greater need exists for self-starting properties than for rigid synchronism.

The complete truck of the locomotive is shown in Fig. 5, there being two motors combined with the two sets of air compressors, the cylinder ends of one set being visible at one end of the illustration. The air-reservoirs are not shown, they may be carried above the motors in a locomotive. In a complete car shown in Fig. 6, one of the reservoirs is shown between the bogies.

This system is so very different from anything at present in use that an actual demonstration of its working cannot fail to be looked forward to with great interest.

At first sight it does not seem very promising, but we may be sure that the careful study given to it by its originator has satisfied him of its goodness in spite of the complexity and cost of the locomotive equipment, and in spite of the well-known low efficiency of compressed air methods.

The loss of heat between the compressing and utilising stages, which accounts largely for the low efficiency of compressed-air working in ordinary cases, is to some extent avoided by Mr. Arnold, who proposes under certain conditions to pass the hot air direct from one cylinder (SC), working as compressor, to the other cylinder (RC) working as a compressed-air motor. But even when this is done, and the heat loss by radiation from pipes and reservoirs is thus reduced, the mere

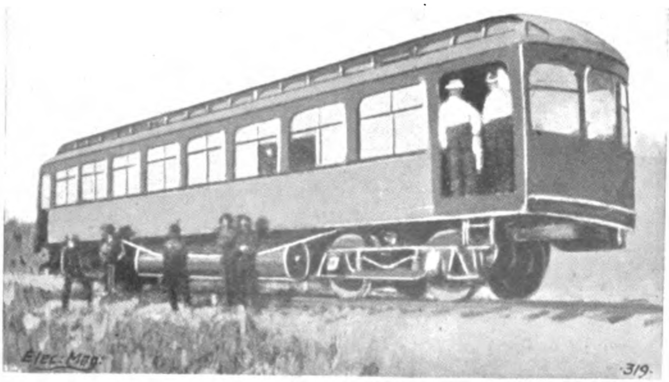


FIG. 6. ARNOLD ELECTRO-PNEUMATIC RAILWAY.
Complete Car, showing Air Reservoir between Bogies.

interchange of power from one end of the motor to the other must involve a large percentage of loss—it is robbing Peter without paying Paul. It may be doubted whether the losses, on the train itself, inevitable with such a system will not be at least as great as they are even with the resistance methods at present used on direct current systems for speed and power control.

Nothing but a practical trial can definitely settle this, and it is to be hoped that Mr. Arnold will soon be able to make such a trial, and so increase our indebtedness to him.

(*To be continued*).

W. M. MORDEY.

◆ ◆

Liverpool and Southport Electric Railway.

THE causes responsible for the conversion of the 18½ miles of railway between Liverpool and Southport to electrical operation are such as will ultimately effect similar changes on equally typical routes in this country. An interurban line served by steam locomotives needed a marked increase in its train service, and under orthodox conditions, the only solution—a very costly one—was to double the tracks and widen the stations throughout the entire stretch of line. The enormous expense of such a procedure suggested, as an alternative solution, the electrifying of the route, and after due deliberation this was decided upon. The Lancashire and Yorkshire Railway Co. are to be congratulated on the step they have so fearlessly taken, and also, as we remarked in our last issue, for their judgment, not to say confidence, in placing the complete contract with a British firm. That Messrs. Dick, Kerr & Co., Ltd., have carried out the work thoroughly, those who have inspected the line can testify, while a glance at the photos (kindly supplied by the Co.) on the next page will add further evidence, were such needed, to the excellence of the designs and arrangement of the apparatus. Work was commenced in March last year, and but for bad weather, the hopes of the management to open the line the same year would not have been disappointed. Considering that 47 miles of single track were converted, and in this length were no less than 46 level crossings, while a large power house and three sub-stations needed erection, the completion of the route in a little over twelve months is a highly creditable performance.

The power house at Formby contains 16 Lancashire boilers, 32 ft. by 8 ft. 6 in. diameter, working at 168 lb., and grouped in two sets of eight each and hand fired. A Green's economiser of 14,400 sq. ft. surface is fitted, as are Galloway's superheaters in the downtake flues. Four Yates & Thom cross compound Corliss horizontal engines, developing normally 2,310 h.p. each, at 75 revs., are installed in the engine room, and each engine is coupled to a 1,500 K.W. alternator by Dick, Kerr & Co. Three-phase current at 7,500 volts, 25 cycles, is delivered by these sets through six H.T. cables to three sub-stations at Seaforth, Sandhills, and Birkdale. Exciting current is furnished from three 100 K.W. Willan's sets. The main switches in the station are all of the oil insulated type.

The sub-stations contain static transformers reducing the line pressure to a low voltage for operating rotary converters, the direct current side of which furnish energy at 600 to 650 volts to the third rail. These machines have an output of 600 K.W., and run at 375 revs. Three air blast transformers of 200 K.W., one for each phase, are provided, and a 5 h.p. fan furnishes the requisite air under a pressure of 2 to 3 in. water.

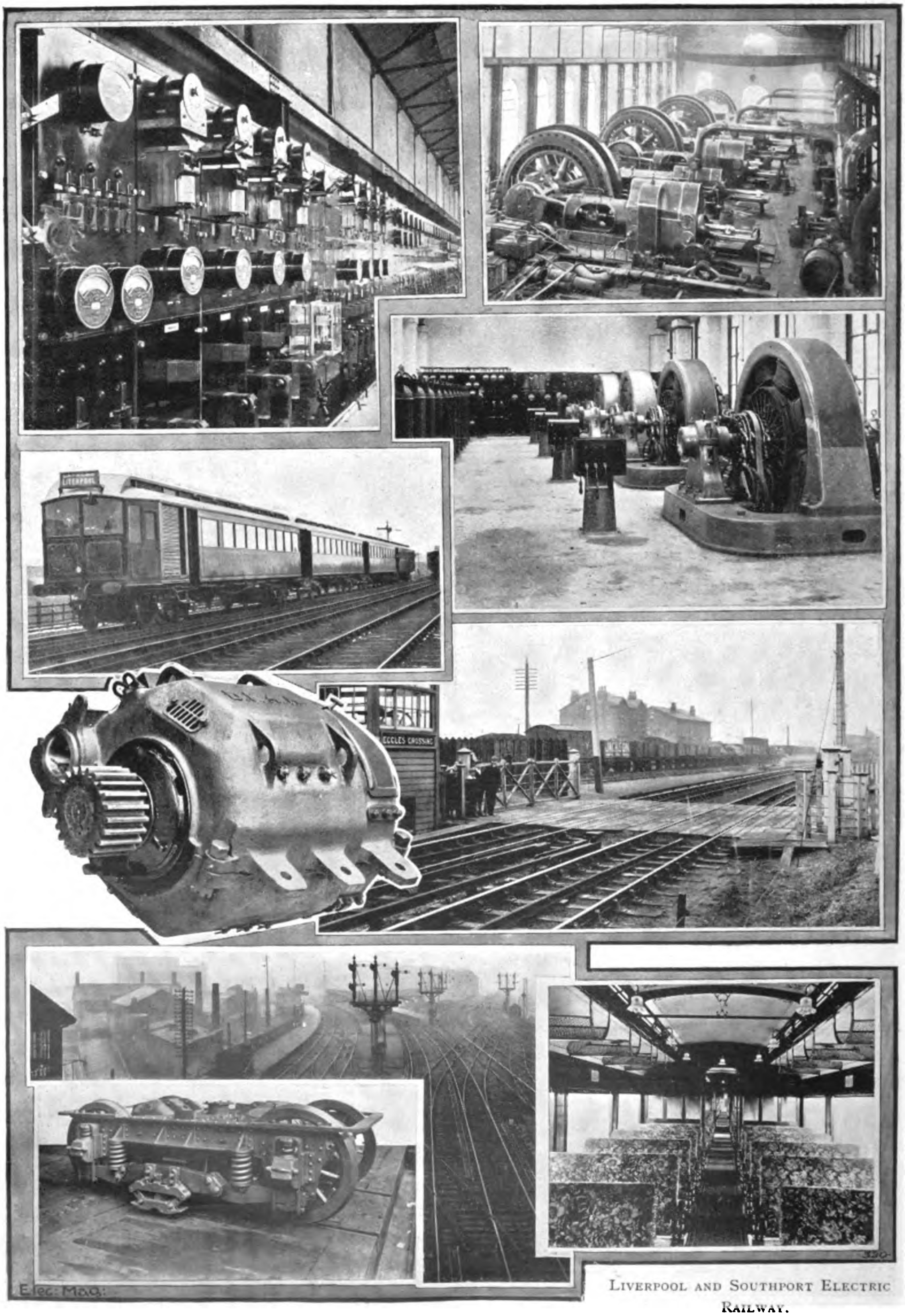
The track is provided with a live rail outside the running rails, and a central rail between these for the return. Each of these conductor rails are of high conductivity steel carried on "reconstructed granite" insulators spaced at 10 ft. intervals. At level crossings the live rail is interrupted above ground and the ends joined by an underground cable. The return is mounted on wooden blocks in the centre of the 4 ft. way, and is connected in parallel with the running rails.

The standard train comprises four cars, the two central cars being trailers and the end ones motor cars. They are 60 ft. long by 10 ft. wide, and will accommodate 66 first and 69 third class passengers. A central gangway has been provided to avoid delay at stations. There are four 150 h.p. motors per car, driving through single reduction gear of 1 to 9·6. The motors at each end of the train are controlled from either driving cab, and each group of four motors are in series at starting and in parallel after speed has been attained. A current of 2,000 amps. is momentarily taken when accelerating, but this drops to 450 to 500 amps. when running.

The entire system is a monument to the labours of English electrical engineers, while testifying to the faith which railway men have in electricity for heavy traction work. We anticipate describing many more such installations in this country before very long.

Testimony Indeed.

A well-known Electrical Engineer writes: "I am more and more impressed with the need for getting railway directors to grasp the kind of problem before them. Your Magazine is much more likely to reach them than the ordinary technical press."



LIVERPOOL AND SOUTHPORT ELECTRIC RAILWAY.

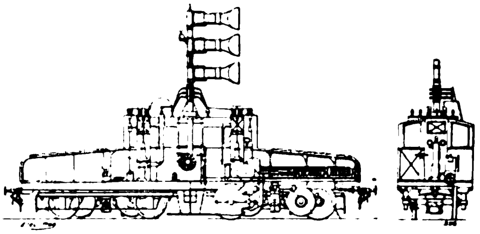
The chief features of the Power House, Track and Rolling Stock. (See page 387).

HIGH SPEED LOCOMOTIVE ON THE MARIENFELDE-ZOSSEN LINE.

It was conclusively demonstrated during the trials of 1901, at Zossen, that at speeds exceeding 160 km. per hour, both roadbed and rails were of insufficient strength ; it was accordingly resolved to strengthen the roadbed and relay the line. Pending these alterations, the engineers of Messrs. Siemens and Halske endeavoured to reduce the enormous weight of the cars, so as to relieve the roadbed of any unnecessary strain, with the result that two new motors were designed to take current direct from the line at 10,000 volts without requiring step-down transformers on the cars, thus reducing the weight by about 20%. To test these motors before the line was relaid, special gearing had to be designed to reduce their speed by one half, as they had been designed for running the cars at 200 km. per hour ; and as the building of a new car would have involved expenditure, a locomotive which could be utilised after the trials for hauling trains, was specially constructed to receive them. This locomotive, shown in the accompanying sketch, is made of steel throughout. The frame is supported on two trucks, with two axles to each truck. The axles, trucks, and truck-boxes are similar in design to the corresponding parts of the high speed cars previously used. On each truck room is provided for two motors. The brakes are of the usual Westinghouse type, and can brake 90% of the total weight, each bogie-truck being separately equipped with a cylinder and an air reservoir. The body of the engine is in three parts. The fore and hind parts, containing the starting resistances, are covered by a sloping roof which runs up to the central cab. The weight of the engine without the electrical equipment is about 24 tons, and reaches 40 when the equipment is included.

Some difficulty was experienced with the gearing on account of the high linear velocity adopted for the rotating parts. Before selecting the most suitable form of teeth many trials were made at Gross-Lichterfelde. The lubrication was found to be very imperfect at high speeds, as the oil did not remain in between the teeth, but was projected radially outwards. With a gear ratio of 1 to 2 a special system of forced lubrication was employed.

Each motor yoke is in two parts, and is entirely similar to the motors previously employed. The primary windings are grouped star-fashion, and placed in micanite insulating tubes. The insulation of the high tension winding was repeatedly tested, and in one test withstood a pressure of 22,000 volts without showing the least sign of weakness. The difference of potential between the rotor windings is about 700 volts during the starting period. Special means are provided for ventilation. When completed, the motors were subjected to a series of complete tests at Charlottenburg. Starting, as well as speed regulation, is obtained by inserting resistances in the rotor circuit. The aerial trolley is placed in the middle of the engine, and comprises a mast held up at two points in the floor and roofing. At the top of this mast are the three collecting bows, pressed up against the line wires by suitable springs. Compressed air for working the controlling apparatus is obtained from a small compressor worked by a 110 volt motor, supplied by a small step-up transformer. Numerous tests of the locomotive were made at gradually increasing tensions and frequencies and at speeds ranging from 35 to 100 km. per hour. The last trial was made at 11,000 volts and 95 km. A 31-ton first and second class passenger car had been coupled to the engine. The highest speed attained was 105 km. per hour. Even at these speeds the gearing was not too noisy, both locomotive and trailer running very smoothly. The energy expended was 260 kws. All these tests showed that the motors were appropriately designed aud that their construction was faultless.



Section of S. and H. High Speed Locomotive.

Outsi.e View of S. and H. High Speed Locomotive.

TRACTION NOTES.

Meters on Electric Cars.

In a contribution to our contemporary, *The Street Railway Review*, Mr. L. B. Pemberton describes the system recently introduced on the Los Angeles and Rodondo Electric Railway, with the object of minimising the waste of electric power. A Thomson recording meter has been permanently fixed in each car, and, at the end of every round trip, readings are taken by an inspector and recorded on a blank similar to that already in use for fare registers. From these slips two monthly reports are drawn up: One of these shows the number of car miles made by each car during the month, the total K.W. hours used, and the average per car mile; the other report shows the relative rank of each motorman, the total number of car miles made by him during the month, and the average K.W. hours per car mile. The report is posted as a bulletin in a conspicuous place, and gives rise to a very beneficial rivalry among the motormen. A diagram, giving the monthly averages of ten motormen, shows a difference of more than 33 per cent. between the highest and lowest average K.W. hours per car mile. The cost of this is more than half the monthly wages of a motorman, and, as the author observes, the difference would certainly have been still greater if no check had been in use. In addition to providing a much needed check on the motormen, the car meters have proved of the greatest value in giving immediate indications of defects, such as hot journals or imperfectly fitted bearings. Some interesting results were also obtained showing the relative effect of live weight and dead load in the power consumption. The average weight of the cars is 34,550 lbs., and the test covered a period of thirty days, and included over 1,000 trips. The results showed that over 85 per cent. of the power used during the heaviest traffic was required to overcome the dead weight of the car, and that an increase of 600 per cent. in the number of passengers gave rise to an increased power consumption of only 17 per cent. These results would be very considerably modified in the case of city traffic, owing to the frequent stoppages; but they showed that the present tendency to increase the weight of the cars is one which should be carefully watched from the point of view of operating expenses.

Electric Traction on Swedish Railways.

ELECTRIC traction is to be tested on two experimental tracks, each 8 k.m. in length, starting from Stockholm, it being contemplated in the near future to electrify the whole of the Swedish State Railways. Mr. Dahlander, acting as expert to the Commission appointed for the purpose, advocates single-phase alternating current, which apart from its well known technical advantages, seems to be specially suitable in this case, because of the great distances and the feeble traffic obtaining. The power will be derived from the abundant sources of water power the country possesses, while for the experimental service now being installed, a provisional steam central station has been provided at Tomteboda.

Everett-Snohomish Interurban Railway.

THE threatened competition of an electric railway parallel to this single line, then operated by steam, has led to its conversion to electric traction. The cars are operated over the old track, which was used by the Northern Pacific Railway for local traffic. The conversion was effected without interrupting the steam traffic, averaging ten trains daily. The track has been bonded with Ohio Brass Co.'s flexible No. 000 bonds, with compressed terminals, expanded into ⅞ in. holes in the rails. The bonds are 12 in. long, and are placed under the angle bars. Cross bonds are fixed at intervals of 1,000 ft. The track will continue to be used by the Northern Pacific steam freight trains, and the effect of this traffic on the bonding will be watched with interest.

The Vesuvius Electric Railway.

THE Vesuvius railway line consists of two sections: In the first and longer section there is no rack, and the gradients are often as steep as 1 in 12; in the second section, about a mile long, a rack is utilised, and the gradient attains 1 in 4. In the present conditions of modern railway practice a line with such a profile would be difficult to work with anything but continuous current. The power-house is near the middle of the line, so as to minimise energy loss in mains, and about 305 h.p. is the power required under the most unfavourable circumstances. Two 550 volt dynamos are driven at 700 r.p.m. by a pair of 100 h.p. Dowson gas engines. The plant also comprises a storage battery capable of giving 260 ampères. When the battery requires charging, the voltage can be increased to 770 volts without any change in the speed of the dynamos. On the steeper parts a second wire on the overhead line is provided to lessen the loss in voltage. Current returns by the rails, which are bonded together by a special metallic preparation. The locomotive is provided with three different brakes: One, an ordinary mechanical brake, is actuated by levers from either platform, and is capable not only of keeping the vehicle at a steady rate on a slope of 1 in 12, but also of stopping it at will; the second brake is electric, and acts by short-circuiting the motors; the third is electro-magnetic, and is preferable to the ordinary shoe brake, because, in addition to its direct action, it increases the adhesion of the wheels and the weight of the car without altering in any way the horizontal component of the force applied, whereas the ordinary brake tends rather to lift the car and diminish the adhesion. When fully equipped, the locomotive weighs 10 tons; its speed, when pushing a car up an incline of 1 in 12, is about seven or eight miles an hour.

TRACTION NEWS IN BRIEF.

Manchester Corporation Tramways. A general description of this system was given in a paper by T. M. McElroy, before the Manchester section of the Institution of Electrical Engineers, on February 16th.

The Mersey Electric Railway. A paper, by H. L. Kirker, read before the Manchester section of the Institution of Electrical Engineers on March 1st, gave a good general description of the system, with detail illustrations of the method of multiple control adopted. The results of operation since the inauguration of electric traction on May 3rd, 1903, show a very close agreement with the original engineering estimates.

Manx Electric Railway. *The Light Railway and Tramway Journal*, of March 4th, contains a full illustrated description of this line—recently re-organised, and a centralisation system adopted. Out of date and worn out plant has been replaced, and the Laxey power station largely added to. Eventually, all the power will be generated there, and the smaller power stations used as converting sub-stations.

Railway System of the Steubenville Traction and Light Co., of Ohio. An interesting point about this system, of which a very good illustrated description has recently appeared in *The Street Railway Review*, is that steam power is used in the generating station. The traction and electric lighting system owes its origin directly to the local branch of the American Gas Co., of Philadelphia, reconstituted under the name of the Steubenville Traction and Light Co.

Electric Railway between St. Georges-de-Commiers and La Mure. An article, by M. P. Letheule, in *La Revue Electrique*, of March 15th, gives a very interesting description of this experimental line, with numerous drawings, illustrative of the engineering details. Power is obtained from the hydraulic station at Acrigonnet, on the river Drac. A Thury hyper-compound dynamo, driven by a Picard turbine, delivers 180 ampères at 2 × 1,350 volts to a three-wire distribution line, the pressure at no load being 2 × 1,200 volts. The locomotive carries four 125 h.p. 600 volt motors, connected in series on the Thury system.

LIGHTING and Heating

Under this heading the development of lighting and heating by electricity will receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., will be comprehensively and impartially described and illustrated.

The Cooper Hewitt Converter.

By the ASSOCIATE EDITOR.

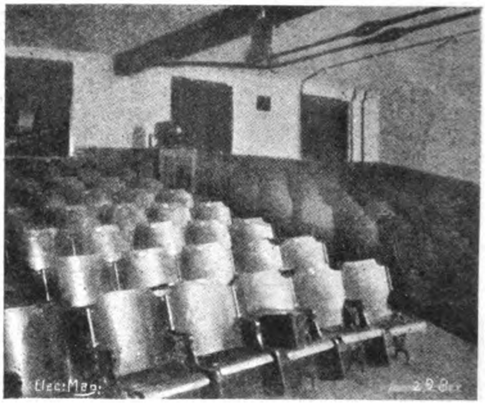
THERE is some reason to suppose that the Cooper Hewitt investigations may lead to a novel form of converter for changing alternate to continuous current. Its discovery was probably due to one of those accidents which happen to every experimentalist, and just at that stage when things begin to look unpromising, something often leads the mind into a new train of thought. It is known that at the negative electrode of the mercury lamp the fall of volts is often very considerable, and it is only by using an electrode of mercury—which seems to be the only suitable substance as yet known—that the lamp can be made to work. This fact, however, is the clue to the converter. Before the column of vapour conducts in the proper sense, the fall of volts at the negative electrode may be as much as 30,000; when started, it amounts to little more than 10 volts, and is almost independent of the current passing, unless the current falls very much, in which case it may rise to several hundred volts with 0·1 ampère. The action of the converter therefore depends on the existence of the high resistance at the negative electrode. Mr. P. H. Thomas describes the converter as being a bulb having one electrode of mercury, the others being of iron, copper, or other suitable material. These latter electrodes cannot become negative, seeing that they are not capable of disintegration, which is seemingly necessary to the breaking down of the high resistance presented by the negative electrode at the start. Current can therefore only pass to the negative mercury electrode, and anything attempting to pass in the opposite direction is suppressed, in consequence of the resistance which its attempted passage causes at the iron or copper electrode. Consequently, current can only pass in one direction through such a mercury column under such conditions, and if the positive electrodes—three in number—are fed with three-phase current, direct current will pass across the bulb, and be available for use in an external circuit. At present the converter is not ready for application to power circuits and its capacity is limited by the current which can be carried without overheating. Further developments are shortly expected; but the present idea is that the converters will be operated in groups. The total loss in the converter, apart from auxiliary apparatus, is about 14 volts, and is practically independent of the current which passes. It seems odd that the whole idea of mercury lamps should in reality be anything but novel. In 1860 an English professor, named Way, produced light by passing current through mercury vapour; but as primary batteries were his only source of power, the idea brought little practical fruit, though it was fully investigated by Trinity House, presumably for lighthouse purposes. Rapieff, in 1879; Rizet, in a patent dated 20th March, 1880; Langhans, in 1887; and Arons, in 1892, pursued the matter further; and now, finally, it has fallen into the hands of Mr. Cooper Hewitt, and seems likely to have a future of much usefulness. It is needless to point out that the converter is not capable of working with single-phase current, but it is said to be available for all voltages between 100 and 1000, and can carry 100 amps. The only loss is that of 14 volts; with 1,000 volts this amounts to 1·4 %.

A NEW FORM OF THE MERCURY VAPOUR LAMP.

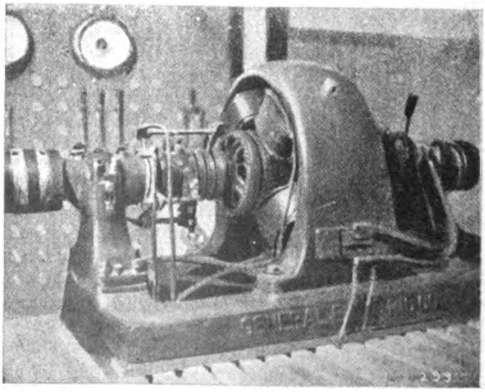
Mr. Bastian, whose name is already well known in connection with electrolytic meters, has designed an improvement to be used with the Cooper Hewitt lamp. Mr. A. E. Salisbury has assisted in the development of this invention, which comprises a device for the automatic tilting of the tube for starting the arc. The usual method employed in America is to tilt the apparatus by hand, but Mr. Bastian's improvement renders the lamp more suitable for use as a fixture. At the moment of switching on, the tube is in a horizontal position filled with mercury, and current passes through the mercury as well as through a resistance, an electromagnet, and a small carbon filament, all being placed in series. The result of this starting current is that the electromagnet is energised, and its plunger, being drawn up, tilts the tube around its pivotted position, so that the mercury falls out of the tube, starting the arc in a manner very similar to that of the American form of lamp. As the mercury falls out of the tube, it short circuits the auxiliary resistance. by coming in contact with two terminals which are sealed into the walls of the glass. The tube itself is of a special shape, so arranged that a slight tilt is sufficient to start the arc, and the pressure of the vapour thus caused, drives the mercury out of the tube without further tilting. The carbon filament continues to burn in series with the arc, and being very much under-run, it is intended to add the red element to the colour of the light, which, as is well known, is very deficient in radiation from this part of the spectrum. Even with the carbon filament at work, the overall efficiency works out at less than 1 watt per c.p., and the life of the lamp is obviously very long, there being nothing beyond an under-run carbon filament which deteriorates to any marked extent. The lamp looks very simple and compact, the mechanism is extremely simple, and if used for street lighting, as intended by the inventors, it should have a sphere of usefulness of its own in electric lighting work. The lamps would have to be run in series, but this is already done in the case of arc lamps, and would therefore constitute no radical departure from existing practice. Each would take about 60 volts, and give 80 c.p., so that on a 200 volt circuit, three lamps would be run in series.

THE COOPER HEWITT LAMP IN PHOTOGRAPHY.

This lamp has many advantages in photographic work. Not the least is the evenness with which the light is distributed, and the high actinic value of the light itself. With an arc lamp, the shadows are likely to be very harsh, and such patches as appear brilliantly lighted, only help to throw the obscurer parts into more profound gloom. The Cooper Hewitt lamp is therefore coming into extensive use in this connection. With a tube four feet or so long, the distribution is likely to be much more uniform than if the whole of the light is given out from the crater of an arc, which has an area of only a few square millimetres. The appended photographs from *Machinery*, N.Y., were taken with the new illuminant, and show the results obtained even under disadvantageous circumstances. The dynamo, shown in the one photograph, was in a corner difficult of access, and the surroundings were coloured in such a way that no great amount of useful light was reflected from the walls. One tube only was used, though in the artistic studio there is usually a group of three used in combination according to the requirements of the moment. Still, without the use of screens or any special means for professional work, results like those shown herewith were obtained. There was, needless to say, no natural light on the occasion of these experiments which were made some hours after sunset. The lens used in taking these views was stopped down to F/16, and the exposure lasted for 10 seconds, far less than is often needed with daylight photography, if the light is more than ordinarily dim. For photographing machinery, or other apparatus, which is often placed in an inconvenient corner of the workshop, and possibly even in such a position that little daylight is available, the Cooper Hewitt lamp seems deserving of a trial.



Lecture Hall Photographed by Cooper Hewitt Lamp.



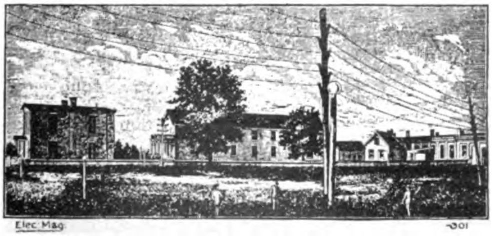
Dynamo Photographed by Cooper Hewitt Lamp.

THE BEGINNINGS OF THE INCANDESCENT LAMP.

THE 25th anniversary of the introduction of the incandescent lamp into the world of commercial activity has been made the occasion of many retrospective studies. *The Electrical World* of New York has devoted a large portion of one of its numbers to a series of articles dealing with the early days of developments, covering ground which has often enough been trodden before, but still seems full of interest.

PHOTO TAKEN BY FIRST ELECTRIC LAMPS.

In one of these, Mr. Edison gives a short history of his part of the work. He started like others, by making filaments of paper, suitably carbonised, and also of wood, bamboo, and other materials, which were cut up with great ingenuity into pieces of appropriate size and shape. The first attempts were made on filaments run in vacuo, being in connection with an air pump. Such filaments would last about one hour. Later the idea occurred of sealing the lamps inside glass bulbs, exhausted by a Sprengel mercury pump, and ordinary sewing thread was used as the raw material. In November, 1879, about 100 paper filament lamps were made, and they had an average life of 300 hours, and one even lasted 1,350 hours. At this point commercial success appeared to be in sight. The finishing touch was given to Edison's share of the work by his device of flashing the filaments in gasoline vapour. The main point which has been incorporated into the present lamp from other sources is the use of a squirtable solution as the raw material for the filament. Swan used a filament prepared from knitting cotton by immersing it in sulphuric acid of suitable strength and so parchmentising it. But both this and all other processes have latterly been altogether displaced by the zinc cellulose solution, which was first worked out by Powell in 1884, and brought into general use after the Edison-Swan monopoly expired. Nowadays, all lamps are made from a solution of cellulose in zinc chloride, exactly as described by Powell, though possibly small details of manipulation vary with different makers.



EDISON'S LABORATORY.
Lighted by first Incandescent Lamps, 1879.

LIGHTING AND HEATING NOTES.

Colour Photometry.

IT is well known that much difficulty is experienced in comparing lights of different colours, and the latest suggestion, which is due to M. Fabry and communicated by him through M. Mascart to the French Academy of Sciences, is worthy of consideration. He proposes to interpose screens before the lights to be examined, and by absorbing certain parts of the radiation to equalise the light emitted on the photometer. The screens are glass vessels containing two different solutions. The first contains a copper salt, to which an excess of ammonia is added, and the second contains a solution of iodine in potassium iodide. Either of these screens may be suitably diluted, and it is merely necessary to standardise them before use in the photometer. A set of tables is therefore drawn up showing the effects produced by the different screens, and from these tables it is possible to determine at a glance the value of a given light after it has been properly balanced against standard lamps on the photometer bench.

The 25th Anniversary of the Incandescent Lamp.

THIS event was recently celebrated by the annual dinner of the American Institute of Electrical Engineers, at which Edison was the guest of the evening. It is now 25 years since the commercial inauguration of the lamp, which has made the fortune of electrical engineering as a business. In the year 1882, the total production of incandescent lamps, was about 100,000. Now 45,000,000 lamps are made and sold in America alone. From these figures it is possible to appreciate the extent to which the business has grown, Still one can hardly resist the feeling, that the whole thing has only been made possible by the merest accident. If we were unacquainted with platinum, or if there were no such thing as platinum, probably there would be no such thing as the electrical engineer. The properties of platinum are unique ; it is comparatively speaking infusible, it can be drawn out into a wire, and it resists oxidation even at the temperature of the blowpipe. Moreover, glass can be prepared of such a nature, that it has the same coefficient of expansion as platinum, and this makes it possible to seal platinum wires into glass, so as to make an air-tight joint. It will therefore be seen, that it is to the fact that platinum possesses these various properties, every one of which is absolutely essential to the purpose to which it is applied, that the growth and even the existence of electrical engineering is due. All the other points in the incandescent lamp, which have been invented and developed by human ingenuity, would probably be fruitless, since the many attempts which have been made to replace platinum have hitherto been unsuccessful. An Edison medal has been founded in America to celebrate this anniversary. It is to be given to the student in each year, who shall, on taking his degree, submit the best thesis on theoretical or applied electricity or magnetism.

Arc Lights for a Canadian Canal.

An object lesson for British Canal Companies.

We learn that an extensive installation of arc lighting equipment is now being carried out on the Welland Canal, in Canada, the position of the terminal station being at Thorold. It is proposed to place an enclosed arc lamp of 2,000 c.p. every 500 feet along the canal, and six lamps at each lock. Three-phase current will also be supplied to motors for operating lock-gates, weirs, bridges, and yard shops on the canal banks. A ten years' contract to furnish the electrical energy has been given to the Lincoln Electric Light and Power Co., of Ontario, and we learn that tenders will shortly be invited for electrical supplies, including arc lamps, transformers, and transmission line material.

Series Arc Lighting.

On one of the Chicago railways, according to *The Western Electrician*, an interesting installation of the electric light has been carried out, consisting of enclosed arc lamps, run on the series system with alternating current. The outlines are somewhat as follows. The generators supply current at 2,300 volts, and this pressure is raised by transformers to 8,600 volts, though a pressure of 4,300 volts is also available by the use of special terminals. Current from the transformers is then fed through the arc lamps, arranged in series. Each transformer is ordinarily used to supply two 50 light circuits in parallel, or one circuit of 100 lights, all in series, with a current of 7 ampères. These pressures seem very high, when compared with ordinary systems in this country; but for the purpose to which the are applied, and with the precautions adopted, the system is found very suitable. Each lamp takes 72 volts at the arc, 76 volts at its terminals, and a total of 86 volts is allowed to include all losses both in the lamps, regulators, and line. Automatic cut-outs are used with the lamps, and a small resistance is substituted for any lamp which is defective.

Street Lighting.

A further report by Mr. Bradley, the Westminster Surveyor, has just been published, in which he states the results of his continued investigations. Again a considerable number of tests have been made, and the averages are given. The light emitted by arc lamps in Westminster varies from 474 c.p. to 605 c.p., this variation being probably due to the form of globe adopted. Sugg's high pressure lamps in Parliament Street gave an average of 573 c.p. on six tests, but the light given by this form of lamp seems, according to the surveyor's notes, to be very variable, and to depend almost entirely on the condition of the mantle. He says that a slight defect in any of the incandescent mantles in high pressure lamps causes a great loss of candle power, and this probably explains the fact that only 29 of them are in use as against 1,145 arc lamps. Still, the Sugg burner seems to be extremely economical, and to be slightly cheaper in working expenses even than the best arc lamps, including under the head of working expenses all the necessary charges towards interest, depreciation, and sinking fund. But the slight advantage to their economy is probably quite outweighed by the superior working capacity of the arc.

Monolateral Illumination with Direct Current Arc Lamps.

In the case of the light given off from an arc lamp having to be utilised in a determined direction only, the lighting power may be increased in this direction by placing the two carbons in an abnormal position, their axes being either in parallel directions at a certain mutual distance or at a certain angle to one another. It was shown from the experiments of Ed. Richter *(Elektrotechn. Zeitschr)* that for each inclination of the axes there was a maximum candle power corresponding to a certain displacement of the carbon; in the case of inclinations of 15, 20, 25, 30, 35, and 40°, this maximum being 141, 107, 69, 47, 26, and 14 per cent. respectively, superior to the amount of light given off from the carbons at the same angle in a normal position. From a comparison between the different maxima it was shown that the latter will increase as they approach the perpendicular position of the carbon axes, and with a corresponding increase in the displacements of the carbons. These experiments were carried out in the optical workshops of Carl Zeiss, Jena.

BREVITIES.

Glasgow Street Lighting.—In the streets there are at present 799 arc lamps, together with 14,753 gas lamps. The flat flame gas lamp is likely to be abolished, and an improved system of lighting is now under consideration.

Hornsey Electrical Exhibition.—There has just been held a very successful show, promoted by the Town Council, at which all kinds of electrical appliances were shown, and much business is said to have been done.

Hampstead Workhouse. Since the installation of a maximum demand indicator, the price paid for current was decreased by £51 in six months as compared with the corresponding six months in the preceding year.

Street Lighting in Leeds. Current is being supplied by the Lighting Committee at the rate of 1¼d. per unit for the purpose of street lighting, though this is said to be 1¾d. less than cost price, when capital charges are taken into consideration.

Drury Lane Theatre. The electric lighting of this theatre has recently been overhauled, and the precautions that have been taken are such that, humanly speaking, there would appear to be no possible chance of a fire occurring, due to electrical causes.

The House of Commons. A system of electric fans has just been introduced for ventilation purposes; but it is as yet not lighted by electricity. An attempt was made to light it electrically in 1883, but this was a failure, and the attempt has not since been repeated.

Electric Light in Germany and America. There are said to be 18,000,000 incandescent lamps and 385,000 arcs in America, while in Germany the corresponding figures are 5,000,000 and 93,000. The total central station capacity in America is 1,225,000 K.W., and in Germany it is 395,000 K.W.

Electric Lighting of Bangalore.—The Maharajah of Mysore has offered free power from the Cauvery Falls for the lighting of Bangalore, and the municipality will contribute 25,000 rupees annually for 15 years for this purpose. The work is in the hands of the British Thomson Houston Company.

Westminster Electric Supply Corporation.—The equivalent of over 59,000 lamps of 8 c.p. has been added to the circuits of this company during the past year, and there is said to be a notable increase in the demand for motive power, and particularly for power to be used in charging motor-car batteries.

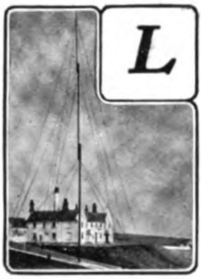
Nernst Electric Light, Limited. It is proposed to reconstruct this company, in view of the fact that a considerable portion of the capital is unrepresented by available assets. The capital will probably be reduced to about £90,000, of which £20,000 will be represented by ordinary shares, and the remainder by preference shares.

TELEGRAPHY & TELEPHONY

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegraphic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

The Trend of Modern Wireless.

By L. H. WALTER, A.M.I.E.E.

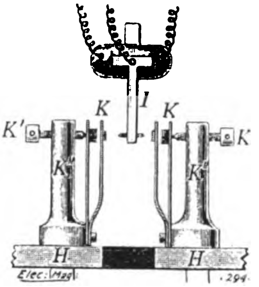


LAST month the wave-directing stage was commented upon, but there is a further stage which, though not yet pronounced, is typical of the direction in which the high-pressure spark-gap and the mercury-vapour gap have been leading: this is the artificial promotion of discharges across the gap. Mr. A. Williams, of Ealing, has devised one method of accomplishing this, which consists in providing a shunt path of high resistance for the discharge, this shunt being made up of material of high specific resistance, such as bauxite, talc or haematite, and so arranged that at one side it is in contact with one spark ball of the main gap, while the other end is approached to the other spark ball so that the shunt gap is smaller than the main gap. The main charge is thus induced to leap the gap by the shunted fraction, the small shunt discharge not being sufficient to lower the potential to any material extent. Where the potentials are very high, the mere bringing of the end of a long bare conductor (on an insulated post) into proximity with one spark ball is sufficient to promote the discharge. There is no doubt that the effect is really due to the ionisation of the air in the gap by the small spark of the shunt discharge. The inventor states that he has found it possible by this means to produce Hertzian waves of greater power from a given apparatus; this is of course due to the fact that the discharge can be obtained across a longer gap—at a higher potential difference.

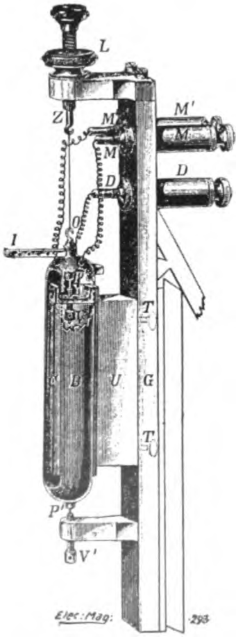
Dr. de Forest, who has also been working on the promotion of gap discharges, claims, in a patent recently issued to him in the U.S.A., the method of ionising the gap to promote a discharge, causing a small spark from an auxiliary electrode to jump from it to one of the main spark balls. This method of de Forest has the advantage of enabling the signals to be sent without any opening of the main high-voltage circuit. It is difficult, however, to see where the invention comes in, seeing that in method and application it is identical with Hertz's famous experiments on the effects of ultra-violet light, now known to be due to the ionisation produced. Such a method is only applicable where a constant high potential is available, such as can be obtained with an ordinary transformer; an induction coil could not be kept working continuously, as it would go on charging the aerial until a sufficient potential was reached for a discharge to take place by itself. A somewhat similar method of promoting a discharge across an air-gap which is normally too long for a discharge to be able to pass, is that of Mr. T. J. Murphy, which was described in ***The Electrical World and Engineer*** some little time ago, though the inventor apparently did not contemplate its application to wireless telegraphy. According to this method an air-gap, between carbon electrodes, is placed in the main circuit (supplied with current at 500 volts or so), and an auxiliary circuit, in shunt to the gap, is supplied from the secondary of quite a small spark coil. On working this coil, so as to produce a spark between the carbons, the main circuit discharges itself across the gap, such discharge ceasing as soon as the auxiliary spark ceases. By the substitution of higher tension alternating current the method could be applied to wireless telegraphy.

THE BAUDOT ON A CABLE CIRCUIT.

Pierre Picard has succeeded in adapting the Baudot apparatus for the Marseilles-Algiers cables with remarkable success. The retardation experienced in cable signalling has been the chief difficulty with which he has had to contend. The capacity in the present case was 130 microfarads for each cable, under which conditions Picard employs a double Baudot, with 12 contacts, having a normal speed of 180 revolutions per minute, the two sectors being used for transmission in the same sense. The relay used is illustrated below, and will be recognised as being evolved from the ordinary type of cable receiver. The contacts made by the tongue (I), which is of aluminium, as will be seen from the diagram, were specially arranged to be, as it were, "dead-heat," two buffer springs, behind the actual contact springs, being faced with pieces of soft material, such as velvet or wool. There is thus no jar, nor tendency to fly off by concussion. A speed of 40 words per minute has been attained with the Baudot, as against 30 words with the syphon recorder worked duplex, with the additional advantage of a printed slip ready for delivery at the receiving office.



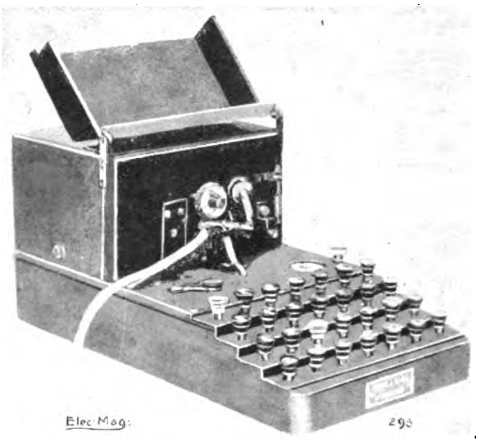
Baudot Apparatus.



Baudot Apparatus.

THE TELETYPER.

The Teletyper of Siemens & Halske was referred to in our first issue, and an illustration of the instrument is now given. Its use on short circuits is giving satisfaction. The automatic starting and stopping of the machine at the receiving end is a great advantage, as also the absence of special synchronising arrangements, required in some printing instruments. The use of the instrument is similar to that of an ordinary typewriter, so that anyone can quickly master it. As soon as the beginning key is pressed down, the circuit of the transmitting apparatus is completed, resulting in a switching roller being set rotating, throwing electric currents of alternating directions into the printing telegraph circuit and through the line relays connected to the apparatus; both in the transmitting and receiving apparatus, local currents, by so-called relay magnets, produce the rotation of the type-wheel from the initial position identically in all the stations. Now, in the case of a letter key being pressed downwards, a peg attached to the other end of its lever will strike against the rotating switching roller brush, stopping the latter and thus the type-wheel of the printing telegraph. At the same time the type levers of both apparatus being attracted will cause the corresponding letters to be printed. As long as the key is pressed downwards, the type-wheels are incapable of moving any further, thus enabling the transmission to take place at any desired speed. After a telegram is transmitted, both the transmitter and the receiver will be switched out automatically at a certain position of the type-wheel, the apparatus thus being stopped.



Siemens and Halske Telescriptor.

◆

THE MERCURY VAPOUR INTERRUPTER.

Mr. G. W. Pierce has recently contributed a very interesting paper to the American Academy. The paper deals especially with the use of the mercury vapour interrupter for wireless telegraphic purposes, in place of the ordinary spark gap in air. The induction between circuits with the two forms of interrupter is investigated, also the resonance between such circuits. The oscillations in the mercury interrupter are analysed by the revolving mirror, and photographs obtained of the discharges. The rapidity of recovery of the interrupter was also determined. Firstly a transformer, supplied with 110 volt alternating current, was caused to charge a condenser in the secondary circuit, in which circuit were also included the mercury interrupter and the primary of a Tesla transformer. With this arrangement much longer sparks and a much more continuous discharge could be obtained with the mercury interrupter than with an air gap between iridium points. Quantitative measurements were made with two Braun type closed oscillating circuits, transmitter and receiver being 20 metres apart. In the receiver circuit the oscillating current galvanometer of Fleming was used as an indicator. The results obtained show that the deflection at the receiver were about four times greater with the mercury interrupter, and measurements of the energy communicated between the two circuits showed that this also was about four times that with the spark gap in air. On account of the great regularity of the mercury interrupter, the closed loops could be tuned quite accurately by the indicator, a very smooth resonance curve being obtained. From photographs of the discharges it was found, as Simon and Reich have already shown, that several discharges can occur during a single half cycle of the transformer, the number increasing with the voltage and with decreasing condenser capacity. With a capacity of ·0043 microfarad and a potential of 15,000 volts, about 60 complete discharges were obtained in the half cycle ($\frac{1}{120}$ second), and the important point was brought out, from the similarity of the distribution of the spark images at the beginning and end of a series of discharges, that the accumulated effect of a number of discharges does not render the bulb conducting, so as to weaken succeeding discharges. Thus after a long operation of the mercury interrupter, with a capacity such that over 200 complete discharges were obtained in $\frac{1}{120}$ second, the complete discharges were only separated by about $\frac{1}{100000}$ second, yet every discharge was sharp and regular, showing that the bulb does not become filled with conducting ions so as to lower the discharge potential to any material extent. The recovery of non-conductivity in the mercury vapour interrupter must therefore be extremely rapid, and fatigue or its equivalent appears to be absent. Comparison photographs of sparks between zinc terminals in air show, in contrast to the mercury interrupter, that the discharges at the beginning of a cycle are strong, but become irregularly strong and weak, the spark gap evidently retaining its conductivity sometimes for so long that the proper charging up of the condenser cannot be effected before the next discharge.

STATE PURCHASE OF TELEPHONES.

THE announcement by the Postmaster-General that pourparlers have been opened with the Directors of the National Telephone Company with a view to the acquisition of the telephone system of the Company throughout the Kingdom, has created widespread interest. Judging from the newspaper comments, there appears to be a general feeling of satisfaction that at last something is to be done to remove the burden which commercial communities of this country labour under and also the reproach which has been directed against this country in being one of the most backward in telephonic development. The view appears to be common that relief can only be obtained by a State purchase. This, in our opinion, is an erroneous view, and probably arises from the false assumption that telegraphs and telephones are alike. Although similar in many electrical respects, their method of operation, their adaptation to public uses, and their administration differ as widely as the poles. Telegraphs lend themselves to central administration, while telephones do not. Telegraphs are general, while telephones are local and individual. The practical administration of telephones covers such a wide range of minute details, many of which are peculiar to individual subscribers and local conditions, that for the Government to successfully operate a huge telephone system it must needs alter the entire traditions which underlie Departmental control. It is well known that in the Post Office administration, provincial officers have little or no initiative. Both policy and methods of operation are conceived and directed from head office, the functions of the local officials being to act in accordance with black and white instructions. Any one practically acquainted with telephone management fully realises how impossible it is to successfully cater for individual wants of communities and individuals unless the local officials are granted a large measure of authority. The question arises, will the Government so alter its methods of department administration as to successfully meet the requirements of an extensive telephone system, or will it retard the progress of the telephone system by insisting upon the maintenance of its traditional methods?

AUTOMATIC OPERATING.

WITH that desire to "Push" which characterises our American friends, the ingenuity of inventors has for some time been directed towards producing switchboards which dispense with the attention of regular operators. The question of "Machine" telephony as compared with the "Manual" system is still within the controversial stage. On behalf of the "Automatic" adherents it is correctly asserted that a great saving in prime cost of operating expenses is effected by the use of an Automatic Switchboard. Telephony differs from most industrial organisations, inasmuch that the extension of a system does not lead to an economy in working. Every telephone administrator faces with alarm any extension of his multiple switchboard, as not only must he provide the additional section, but additional jacks have to be fitted in every section of the board previously erected. Besides, the necessary complications of work necessitates greater expense in operating. In the Automatic board any reasonable addition can be carried out without unduly increasing the cost of apparatus and operating. On the other hand advocates of the "Manual" system maintain that an Automatic Switchboard is too complicated and has too many contacts and that to rob telephone operating of its human assistance is to deprive it, not only of what subscribers have been accustomed to, but of a variety of incidental services which only human operators can perform. It may be concluded that subscribers prefer being told that "No, so and so is engaged," that "he will be rung up when free," that "the lines are busy," and "the subscriber won't answer." These objections, however, can be overcome by the attendance of a few intelligent operators whose duties would consist in satisfying the wants of the curious and impatient subscribers. With regard to the argument of complication and too many contacts, this is purely a question of perfection in construction and maintenance.

Amongst the chief Automatic boards might be mentioned the Strowger, Fuller (Automatic and Semi-Automatic) and the Lorimer.

A Strowger automatic apparatus was a few years ago installed in the municipal offices in Glasgow, and, so far as the writer is aware, is the only one in this country. One of the most commendable features of the Fuller system is the semi-automatic, which lends itself to adaptation to existing plant, thus obviating the necessary of extenting the multiples and at the same time reducing the cost of operating. No alteration in the subscribers' plant is necessary, apart from the addition of a selector sender contained in a small case of about five inches square.

MEASURED SERVICE AND PARTY LINES IN THE UNITED STATES.

At present there is a strong movement of the independent telephone companies in the U.S.A. towards measured service and party lines, both of which the independent in his infancy was decidedly adverse to. Most of the independent companies at the start made no provision for party lines, and all rates were flat, the subscriber paying the same whether he made one or one thousand calls a month. Party lines were regarded only as contrivances to irritate subscribers and as costing more to maintain than the increase in revenue they provided. This prejudice was partially caused by there being then no absolutely reliable four party system manufactured by independent makers. Lately all have come to realise that purchasers should pay for exactly what they use—no more, no less—and that there should be a class of service provided to accommodate all possible users, from the individual making but one call a day to the corporation making several hundred. So now where new plants go in, so do party lines; and old plants, which have not been paying as they might, are installing party line apparatus. In the larger towns, where measured service is practicable, they are awakening, and the subscriber pays according to the number of calls he makes. A good example where such an adjustment is to be made is Cleveland, Ohio, where the rates on individual lines are to be raised, and a lower priced party line service provided, which will reach those who, in the past times of higher rates, could not afford to have a telephone at all. The old rates for business telephones were $48 a year, and for residence $36 a year. No other classes were provided. Since the rate and service agitation, the following schedule has been decided on :

	Unlimited Service. Quarterly.		Measured Service. 150 Calls Quarterly.	
	Business.	Residence.	Business.	Residence.
One Party ...	$18.00	$12.00	$15.00	$10.50
Two ,, ...	13.50	9.00	11.25	8.25
Four ,, ...	9.00	6.00	7.50	5.25

It will be noticed that the rates for business individual service will be an increase over the old ones, while a party line can be had for much less. It has been figured that under the revised rates, 37% of the present users will have their rates raised, 5% will pay the same as at present, and 58% will get practically all the service they need at less rates than those now in force. The company estimates that the readjustment will increase its annual revenue by $35,766. The change in rates will take place simultaneously with the cutting in of a new modern central energy lamp signal switchboard which replaces one of the divided multiple type that has not been giving the best of satisfaction for some time past.

AMERICAN APPLICATIONS OF PUPIN'S INVENTION.

Ever since The American Telephone and Telegraph Co. (The American Bell) purchased the American rights for his invention from Prof. Pupin, it has been generally known that the corporation has been conducting experiments with the system, but because of the "silent" policy of the company no results have been made public. It has been rumoured, however, that the tests on overhead lines were not as successful as anticipated, unforeseen difficulties in the nature of cross talk and leakage having been encountered, as well as some trouble with the inductance coils when under the influence of electric storms. At any rate there has been no improvement noticed in the transmission between New York and Chicago, the line on which the experiments were said to have been conducted. Last spring reports were published of a series of tests conducted by Messrs. Siemens & Halske, who were the purchasers of the German rights for the invention, which were interesting, giving actual figures and results obtained. Until recently these contained all the available information on practical results and installation of the patent. Lately some meagre information has been made public, and while they are bare of numerical facts of interest to the engineer, they at least show that something is being done and that the method can be applied successfully at least to underground circuits. Chief engineer J. J. Carly, of the New York Co., is authority for the statement that his company has installed a loaded cable, underground, from New York City to King's Bridge, which is well into the suburbs of the city, a distance of about fourteen miles. This cable will carry the long distance circuits from Chicago, Boston, and the other cities which formerly came in on an overhead pole line. The line, which is practically the only one existing in New York City, will eventually be abandoned. It was stated in the course of the interview that the New York Company had found that one mile of underground circuit has as much cutting down effect on the transmission as twenty-eight miles overhead, so that the fifteen miles of underground circuit in New York would have cut down the voice currents as much as 840 miles of overhead circuit, or practically the whole distance between New York and Chicago.

From a Telegraphic Contemporary.

The following from an enterprising rival is encouraging : "We are pleased to receive a copy of your magazine, and beg to say we consider it a handsome production. It looks like jumping from birth to mature manhood at a single bound. We wish you every success."

TELEGRAPH NOTES.

Underground Wires.

THE writer referred to above, citing the opposition evidenced to the removal of overhead cables in New York, states that doubt was cast upon the possibility of getting a cable in a conduit or subway to show an insulation resistance of 15 megohms per mile, per 100 volts of applied pressure. The question had come up some fifteen years ago, but the anticipated difficulty was not found to exist. It is presumed, however, that the writer of the article refers to tests taken before the several sections of cable were jointed through the manholes and boxes.

Switchboard for Fire Alarms.

A NEW fire alarm switchboard for Richmond, New Brighton, in Staten Island, is constructed of slate panels in steel frame. It comprises 14 box circuits and 8 gong circuits.. All the apparatus applicable to each circuit is mounted upon a separate panel. Alarm issignalled by means of a four-candle power incandescent lamp, behind a bull's eye of ground glass, on which the number of the circuit is painted. The relays are non-combustible and mounted on the backs of the panels, the armatures protruding through the front. Each circuit has a jack for insertion of a telephone plug, by means of which the operator may speak to any man on the line who may be at a box, and a pen register.

Code in Telegrams.

EVER since a designing public has set itself to work to construct means of diminishing its telegraph bills in the face of high cable charges, there has always been dispute as to what combinations of letters shall be admitted in international telegrams, which may not be regarded as infringements of the spirit of international regulations. It seems that the recent concession by the Postmaster General, that artificial combinations can only be passed if easy to pronounce and to transmit, will rather aggravate the difficulty in making and using codes, as ideas on the first point may necessarily vary considerably, although from an operator's view there may be a consensus of opinion on the second. No doubt some day we shall come to the sensible plan of charging on a single letter and figure basis.

Automatic and Type Printing Telegraphs.

MR. W. MAVOR, Junr., writing in *The Electrical World & Engineer*, recalls the fact that during the past thirty years a number of rapid automatic telegraph systems have been tested in the United States, to be operated at 800 to 2,000 words per minute. None of these have, as a matter of fact, survived, and the Wheatstone's system, which had its birth in England, is still able to compete with any other used for ordinary commercial work. In France the Baudot synchronous printer, by which four messages are simultaneously transmitted over one wire, is now utilised on all the important through circuits, and affords a capacity of about 110 words per minute to each circuit. In this system, as well as in the case of the Hughes printer, which is also employed largely in Europe, the message is printed on a paper strip as received. In the United States the Buckingham printer, which operates at a speed of about 100 words per minute, in each direction, is employed on circuits from 500 to 1,000 miles in length. By this system messages are printed in page form on the ordinary telegraph blank as received. Two other important page-printing telegraph systems, namely, the Murray and Rowland, are now being experimented with in the States and Europe.

Among other developments of electrical telegraphy in the last 30 years has been the Delany synchronous system, which transmits four to six messages at once on one wire. The writer would seem to be under the impression that this system is still used in Great Britain, but we believe that it has been discontinued. Of other notable improvements and multiplex devices he notes that another exceedingly valuable invention of recent years is that of Van Rysselberghe, by means of which it is possible to telegraph and telephone over the same wires at once; that is, while the two wires of the telephone circuit are being utilised or the transmission of speech on long-distance wires, both wires may at the same time be employed for ordinary telegraph purposes. In the States many telephone circuits are, by means of this system, operated also as telegraph wires. On the other hand, the telegraph wires are used exclusively for telegraph purposes, but little effort having been made, it would seem, to utilise telephony as an adjunct to the regular business of telegraphy, which has long been an occasion of some wonder to the writer, although he is not unmindful of the difficulties of the matter. It should, however, be added in this relation that some of the telegraph wires of the railway companies are utilised for simultaneous telegraphy and telephony. As long ago as 1890 the writer connected up the first set of apparatus for this purpose in the New York office of the telephone company for an experimental circuit between that city and Philadelphia. He considers that quadruplex working has fallen off in the States, owing to the difficulty in maintaining sufficiently constant conditions for the B side, said to be occasioned by the proximity of electric traction and other high potential wires.

TELEPHONE NOTES.

A Question of Price.

UPON the question of price will entirely depend whether or not telephone service in the future will be cheap. Whatever price is paid by the State for the existing system of telephones, a considerable part of it will cover watered capital and thus be unproductive of revenue. Moreover, to bring the present telephone plant up to a condition in keeping with the Post Office standard of work will necessitate a further expenditure of capital which in itself will not add to the revenue. It is, therefore, difficult to see how it will be possible for the Government to lessen the telephone rates to an extent satisfactory to the public. The Post Office will be expected to waive the Royalty charge, which means a reduction of £1 in every £10 subscription. The question will naturally occur to the telephone subscriber, what further reduction will be possible?

WIRELESS TELEGRAPH NOTES.

Wireless Telegraphy.

A SERIES of articles on wireless telegraphy is now appearing in our contemporary, *The Electrical Engineer*. Up to the present the papers have contained mostly only preliminary remarks which are in many cases not very closely related to wireless telegraphy, and the only practical methods dealt with have been the conduction (earth) methods among which our old friend the ever-youthful Armstrong-Orling system again figures. It is hoped to be able to refer again to Mr. Blaine's articles when they have arrived at a more mature stage.

Enterprise of "The Times."

THE *Times* will always be remembered for its loudly heralded but short lived Marconigram column. It has now published a very long message transmitted by wireless telegraphy from the despatch boat, fitted up by *The Times* with such commendable enterprise, now with the Japanese fleet to Wei-hai-wai, from whence it has come by cable. The installation is on the de Forest Co.'s system and is said to have a range of about 100 miles. It is to be hoped that this interesting feature will be continued.

The Marconi Co. and others.

THE Marconi Co. should almost begin to feel satisfied. The agreement with the Admiralty has been concluded, and all is now satisfactory in that direction—from the point of view of the company. The Post Office agreement has now been brought to a practical issue. This will no doubt be of considerable advantage in facilitating the extension of the system, and will give the company what it has been fighting for so long—the practical monopoly of wireless telegraphy in England.

When Experts Differ.

VERY little information is available as to the reliability of wireless telegraphy under all and varying conditions of weather and atmospheric state. Prof. Fessenden, some time ago, pointed out that during 1900 and 1901, the wire telegraph and telephone services between Cape Hatteras and Manteo, Roanoke Island, were both interrupted on 27 days, but that there was no day on which wireless messages could not have been sent had there been a regular staff of operators. This at best, is only of the nature of negative evidence. Capt. Ferrié, on the other hand, referring to the actual records obtained with the Martinique and Guadeloupe emergency stations, found that the service was interrupted every night, owing to atmospheric and terrestrial electrical phenomena and sometimes also in the daytime, but only two or three times a month, though, of course, allowance has to be made for the tropical situation of these latter stations, which renders them more liable to interferences of this nature. Prof. Fessenden holds that, by using circuits of sharp selectiveness, atmospheric effects can be eliminated. Capt. Ferrié, however, even in his most recent lectures, declares that the only method to get rid of the greater number of such disturbances, is to increase the amount of energy employed at the transmitter, and to work with less sensitive receivers.

Heligoland Wireless Telegraphy.

FROM the wireless telegraphy station, installed at Heligoland more than a year ago, signals and telegrams were recently transmitted both to the steamer Cap Blanco, of the Hamburg-South American Steamship Co., as well as to a Dutch station installed in Amsterdam within the docks, with absolute clearness and without any mistakes. The system employed was the "Telefunken," used by the Gesellschaft für Drahtlose Telegraphie. This result is the more remarkable as the distance is more than 180 miles, while in spite of unfavourable conditions, the instruments of a normal wireless telegraphy marine station proved quite sufficient without the necessity for resorting to such enormous plants as are used by the Marconi Company.

A System with New Features.

A SYSTEM of wireless telegraphy, devised by Lieut. W. S. Hogg, of the U. S. Navy, and disclosing some new features, has lately been patented. Lieut. Hogg proposes to secure the system against interference by employing two tuned aerial circuits, each resonant to a different frequency, and two coherers, one for each aerial circuit, arranged in series, so that no signal will be recorded unless both the coherers have been affected. A convenient combined variable self-induction and capacity device is also described, which enables tuning to be easily effected, the inductance being capable of extremely delicate adjustment. The most novel feature is a new device called an intensifier, used to increase the E.M.F. of the oscillations, in place of the oscillation transformer commonly employed for that purpose, it having the advantage over the latter of simplicity and ease of construction. This intensifier also eliminates atmospheric effects, being so connected that atmospheric discharges are led to earth without affecting the coherer. The intensifier is made up of a strip of tinfoil between paraffined paper, the tinfoil being then folded zigzag fashion so as to have as many folds as possible, the space between the folds being filled in with wax or paraffin. The ends of the tinfoil are connected to terminals, and metal collector plates are placed upon the wax over the edges of the folded tinfoil. The inventor considers that the waves by their dynamic effect in traversing the tinfoil act inductively and set up intensified vibrations in the collector plate, which are communicated to the coherer.

WIRELESS WAVES.

Marconi at St. Louis. The Marconi Company, whose intention to exhibit at the St. Louis Exhibition is well known, has now definitely announced that it will show examples of the Marconi instruments in the Italian section of the exhibition.

At the Front. A dispatch from Port Arthur states that it is impossible to use the wireless station at the lighthouse there, as the Japanese have, by the efforts made by those ships fitted with wireless apparatus, disabled the instruments.

"The Times" Wireless Dispatches. The de Forest apparatus on *The Times* dispatch boat has had a breakdown. This was due to no fault in the electrical equipment, but was owing to an accident to the aërial wire. This has now been repaired, and articles are again appearing in *The Times* headed "By Wireless Telegraphy."

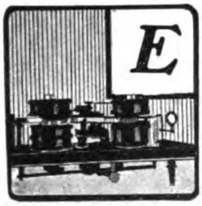
Belgian Coast Stations. The wireless telegraph stations on the Belgian coast have been open for the reception of messages from the public since March 15th last. It is now possible to communicate with ships in the Channel: a charge of 20 centimes per word, in addition to the ordinary telegraph tax, being made.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable; that coal may absolutely be removed from the ranks of necessary commodities; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

Some Notes on Electro-Galvanising.

By SHERARD COWPER-COLES, M.I.E.E.



ELECTRO-GALVANISING, or, as it is commonly called, cold galvanising, as distinctive from hot galvanising, has developed into an industry of considerable importance. Almost every large shipbuilding yard in England and on the Continent has an electro-galvanising plant, and it is extensively used for coating with zinc, boiler tubes, condenser tubes, and the frames and plates for torpedo boats and destroyers. The process is employed for two purposes, firstly, for depositing zinc as a permanent protective coating, secondly, for flashing iron work with zinc, to give a temporary protection during construction and erection, and also for detecting any flaws in the iron or steel before the expense has been incurred of rivetting in the plate or assembling all the parts of a boiler; great economy and large sums of money have thus been saved. Electro-galvanising is also used for coating very small articles and fittings which are electro-zinced in revolving barrels so as to ensure a more even distribution of zinc. In the original plants, the first of which was erected by Messrs. Laird Bros., at Birkenhead, difficulty was experienced with the zinc anodes, which caused the composition of the electrolyte to vary considerably and consequently the nature of the deposit. This has been overcome by employing a regenerative process. Zinc in a fine state of division is placed in filter tanks through which the electrolyte is continually circulated by a small centrifugal pump.

Satisfactory results can only be obtained when the work is electro-zinced under proper supervision, in a plant capable of fulfilling the conditions necessary to obtain an adhesive coating of zinc free from perforations. Electro-galvanised steel test plates, when exposed to the weather in a manufacturing district for over five years, on examination showed little or no signs of deterioration; on the other hand, if the work had not been zinced so as to ensure a continuous non-porous coating, the zinc coating would have possessed no protective value, and signs of rust appeared a few months after exposure to the weather. Iron, when dipped in a bath of molten zinc, cannot have less than a given amount of zinc, about one ounce per square foot (except in the case of sheets and wire where the zinc is reduced by mechanical means) the thickness of the coating depending upon the temperature of the zinc, and the rate at which the iron is withdrawn from the molten zinc. Work to be cold galvanised may be placed in the bath for an hour or more, and withdrawn with practically no zinc on it, due to a bad electrical connection or the electrolyte offering too high resistance, or to the bath being too acid. On numerous occasions work has been shown to the writer which has had a good appearance, but which, when tested, was found to be only coloured

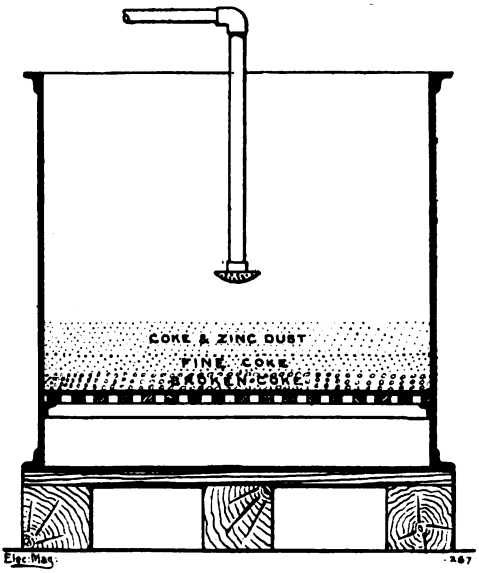


FIG. 1. ZINC POWDER FILTER BEDS.

or "flashed" with zinc, due to one or more of the reasons already given, or too small a dynamo for the size of work under treatment. Work of this class is bringing the process of electro-galvanising into disfavour with many engineers; but if the work is electro-galvanised under proper supervision, and in a plant which embodies all the conditions found necessary to succes, the results obtained are suitable for many classes of work.

The Admiralty specifies that all boiler tubes should be coated externally with a coating of zinc equal to 1¼ ozs. per square foot, and that economiser tubes should be coated inside and outside with an equal thickness. Electro-galvanising can be tested by the Post Office or Preece's test as applied to hot galvanising, *i.e.* by dipping the zinced iron into a saturated solution of copper sulphate for one minute, when the test piece is removed, wiped and replaced. This is continued until a red adhesive deposit of copper is obtained, showing that the iron is exposed. For adhesion, the usual bending tests are applied.

Mr. C. Richter has given much attention of late to the testing of iron and steel electro-galvanised and hot galvanised; he has drawn up a table, published in the *Electrochem. Zeit.*, 1902, and suggests that comparisons should be instituted between the following groups of properties:—

A. Geometrical and optical properties of the metallic film, comprising (1) form; (2) colour; (3) lustre.

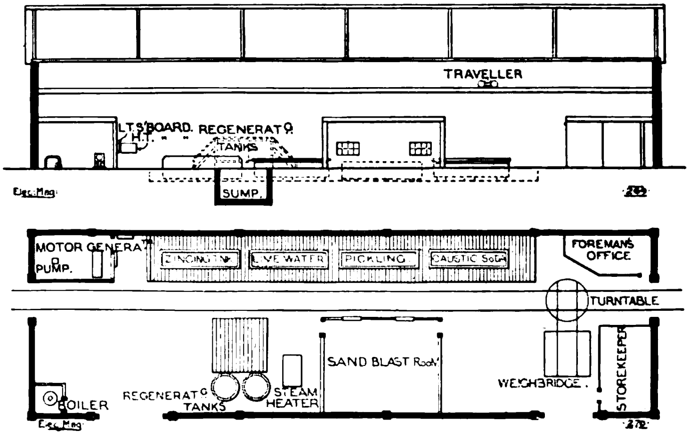
B. Mechanical properties of the film with and without reference to the material coated, comprising (4) hardness; (5) continuity; (6) elasticity; (7) tensile strength; (8) adhesion.

C. Chemical and electro-chemical properties of the plating with and without reference to the object plated, including (9) chemical composition; (10) power of resisting corrosion; (11) protective power.

D. Thermal properties (12) co-efficient of contraction and expansion.

Experience has shown that an electro-zincing plant, to give continuous and satisfactory results, must be so arranged, that it is practically automatic, and can be placed in the hands of any intelligent workman. These conditions have been successfully filled by doing away with zinc anodes and subsituting insoluble lead anodes, and replenishing the zinc deposited from the electrolyte, by passing it over filter beds containing zinc powder or dust, Fig. 1. The general arrangement of an electro-galvanising plant suitable for a shipbuilding yard, is shown in Figs. 2 & 3. The compound anode and cathode bar, shown in Fig. 4, enables the anodes to be brought much closer to the work to be electro-zinced, than would otherwise be the case. Lead anodes require a higher electric motive force than zinc anodes. By the adoption of the compound anode and cathode, the voltage can be reduced to less than that required for zinc anodes.

One of the most recent plants that has been erected in this country is for Messrs. Henry Tate & Sons, Ltd., sugar refiners of Silvertown, E. This comprises two electro-zincing tanks 6 ft. x 5 ft. x 5 ft. deep, constructed of wood and lead lined, the solution being heated by means of lead steam coils. A washing tank of the same dimensions is placed near the zincing tanks, into which the work is dipped after removal from the zincing tanks. The electrolyte,



FIGS. 2 AND 3. GALVANIZING PLANT FOR SHIPBUILDING YARD.

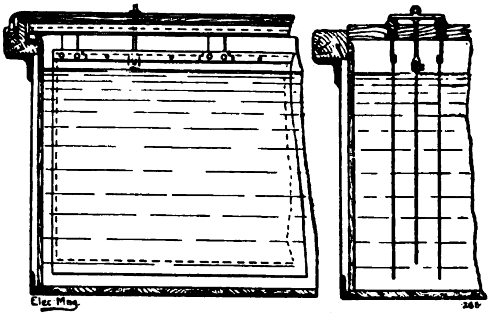


FIG. 4. COMPOUND ANODE AND CATHODE BAR.

composed of zinc sulphate solution, is circulated through the zincing tanks by means of a pump, the solution being lead from the overflow of the zincing tanks into a sump, and from thence it is pumped to the regenerating tanks and sprayed over filter beds consisting of zinc dust mixed with finely divided coke. In practice, it is found very important to keep the electrolyte slightly acid, otherwise, the zinc coating will not be adhesive and have a tendency to blister. The best proportion of free sulphuric acid, is about one-tenth oz. of free sulphuric acid to every gallon of water. The amount of free acid in solution is quickly determined by the workman in charge who used gelatine capsules containing a known quantity of alkali. A small proportion of lacmoid solution is then added, and the condition of the solution readily determined by the colour tests.

Messrs. Henry Tate & Sons, Ltd., sand blast all their work before electro-galvanising, as a large proportion of it consists of hollow steel work which is liable to retain some of the acid if placed in pickle and finally cause corrosion. The dynamo gives a current of 2,000 ampères, and an E.M.F. of 8 volts. Such a plant can be worked continuously for months without the necessity of stopping for cleaning out the tanks or renewing the anodes, as the solution is constantly being filtered by passing through the filter beds. So long as these beds are kept replenished with zinc dust, the plant requires no further attention beyond the stopping of the pump if the solution is found to be getting too neutral. The use of zinc dust in place of zinc anodes, is found to effect a considerable economy. Zinc anodes do not dissolve freely, and soon become disentegrated and fall to pieces, rendering the electrolyte foul and the deposit of zinc rough. Thin sheet lead anodes, which are used in combination with the zinc dust process, also have the advantage of being pliable, so that they can be readily bent to the contour of the variously shaped articles required to be electro-galvanised.

The reference section of "The Electrical Magazine" (see pp. 443-4) is one of its most valuable features. For this alone it is worth double the annual subscription.

BLONDLOT'S N RAYS.

BLONDLOT'S recent discoveries afford a striking confirmation and explanation of the fact, that experiments with N rays cannot be reproduced with any chance of success in a lecture before an audience. Certain observations made during an experiment of a very complex nature, by Dr. Guilloz, led Blondlot to suspect that in addition to the ordinary rays, there existed another kind possessing properties, diametrically opposite to those of the former. A closer study of the feebly deviated parts of the spectrum revealed the existence of such rays, which Blondlot calls N_1 rays, and the action of which on phosphorescent substances is to diminish their luminosity instead of increasing it. By measuring their wave-lengths and corresponding indices for aluminium, Blondlot was able to draw up the following list, which gives an idea of the position in the spectrum of these new rays with regard to the former.

Rays.	Index.	Wave-length.
N_1	1·004	0·003 μ
N	1·0064	0·0048
N_1	1·0096	0·0056
N	1·011	0·0067
N_1	1·0123	0·0076
N	1·029	0·0083
N	1·041	0·0087

Certain sources seem to emit exclusively N_1 rays, *e.g.*, copper, lead, silver and wire-drawn platinum. Bichat finds that ethylic ether, when in the state of strain produced by Berthelot's method, acts as a source of N_1 rays. They can be stored by different substances in the same manner as N rays. Quartz when placed near a stretched copper wire, will emit N_1 rays for some time.

If a phosphorescent screen, or more generally any dimly illuminated surface, be viewed normally, the action of N rays impinging on this surface is to make it appear more luminous. If, on the other hand, this surface be looked at sideways, or nearly tangentially, its brightnes decreases. This is another of Blondlot's discoveries, and has been confirmed by experiments, with all known sources of N rays, sound waves, magnetic fields, electromotive forces, etc. Thus, it appears that N rays, whether they increase or not the total quantity of light emitted by a body, alter at any rate the distribution of this light. In a more recent communication, Blondlot differentiates the actions of heat and N rays on phosphorescent substances. Heat causes an increase in brillancy in all directions, while N rays hehave in the manner aforesaid.

Bichat conbributes a note to the *Comptes Rendus*, in which he gives a list of different metals, with their respective transparencies to N rays of various indices. Silver is transparent to all radiations. Gold is opaque to rays having indices 1·04, 1·196, 1·136, 1·40, and transparent to the others. Palladium, nickel and iridium, are opaque for all indices. Pure lead is transparent to some rays, but the coating of oxide and carbonate with which it is habitually covered, renders it opaque. In another communication, Bichat describes some experiments which show that gases in a liquefied condition emit N rays. If a tube containing liquid carbonic anhydride be heated above the critical point (say 40 degrees C), it ceases to emit N rays. But if left to cool, the rays reappear at the moment when the mist of liquid gas begins to form in the tube. The extremely small wave-length of N rays would lead one to infer that the phenomenon of magnetic rotation of the plane of polarisation, would manifest itself in a much more marked fashion with N rays than with ordinary light. In a recent issue of the *Comptes Rendus*, M. Bagard describes some experiments which confirm this supposition. Subsequent researches by M. Bagard, point to a similar conclusion with regard to the natural rotatory power of certain substances. Thus with rays of index 1·04 (aluminium), and wave-length $0{\cdot}00815\mu$, a sugar solution is 700 times more active than with ordinary light. M. Gutton finds that in addition to the effect produced by non-uniform magnetic fields, to which we referred briefly in our last issue, a similar effect is noticed with moving fields. When a variation of magnetic field or a motion of lines of force produces electromotive force at a point where some calcium sulphide is placed, an increase of brightness can be observed. M. Charpentier has experimented with N rays on the organs of sense. He finds that N rays have a marked influence on the sensibility of the olfactory and auditory nerves. N_1 rays, on the other hand, tend rather to diminish the sensibility of the nervous system, the effect being contrary to and symmetrical with the effect produced by N rays.

ELECTROPHYSICAL NOTES.

Kathode and Canal Rays.

F. Leininger, in *The Philosophical Magazine* for February, describes experiments bearing on the relation of the electric charges transported by kathode and canal rays to the exciting current.

The Hertz Grating Experiment.

It is well known that Hertz, as far back as 1888, showed that electric oscillations traversing the air and striking a grating of metallic wires, will be decomposed into two components; the vibration parallel to the wires being reflected, whereas the perpendicular vibration is transmitted without any appreciable diminution of intensity. By showing similar phenomena to occur in the reign of the visible spectrum, a further evidence of the identity of visible light oscillations and electric waves would obviously be obtained. This is done by Prof. F. Braun who, in a communication to the Berlin Academy of Sciences, repeated the following experiment, made by Prof. Kundt in 1886; on horizontal glass plates placed below a thin vertical metallic wire serving as cathode in the vacuum, metallic mirrors were obtained by the cathodic projection from the wire; these were examined in the practically parallel light between two crossed nicols, when a lighting of the field of vision together with a dark cross parallel to the polarisation plane was noted. This phenomenon, ascribed by Kundt to double refraction, is nothing else than the optical analogon of the Hertz phenomenon, the grating being constituted by the metallic particles.

Relations between Optical and Electrical Qualities of Metals.

A valuable research dealing with this important subject has been translated by the authors, Profs. E. Hagen and H. Rubens, from their original German paper, and is published in *The Philosophical Magazine* for February. The results afford further confirmation of Maxwell's electromagnetic theory of light, and show that, in the case of long waves, neither the vibration period of the molecules nor the magnetic qualities of iron and nickel produce any appreciable effect. It is shown that absolute determinations of electrical resistance may now be made by the sole aid of radiation measurements.

The Magnetic Decomposition of Radium Lines.

In a paper recently read before the Berlin Academy of Sciences, C. Runge and J. Precht investigated the strongest lines given by the spark spectrum of radium, showing that a magnetic field will produce the same decomposition as was observed in the case of Mg, Ca, Sr, Ba. This decomposition is identical not only qualitatively with respect to the number of components and to their relative intensity, but even quantitatively, the distances being measured in terms of the number of periods. As regards a possible connection between the number of periods corresponding to homologous lines and the atomic weight of the element, a simple relation is found with the second secondary series. A similar connection is stated in the case of both the main and the two secondary series, when considering the differences of each two numbers of periods corresponding to a couple of lines, in terms of the atomic weight. In fact, the empirical formula

$$y = c.x^n,$$

where y is the atomic weight, x the difference of the number of vibrations, and c and n certain constants, appears to represent the experimental results. These results show radium to belong to the group of alkalic earths.

Arcs in Exhausted Tubes containing Metallic Vapours.

A most valuable research in this subject, carried out by Dr. E. Weintraub in the Research Laboratory of The General Electric Co., of Schenectady, is described in detail by the author in the February number of *The Philosophical Magazine*. It is shown that the surface condition of the kathode, but not that of the anode, largely affects the starting of the arc, and that a mercury arc may be conveniently started, at a moderate voltage, by bringing a kathode in contact with an already active electrode, even in long tubes. Various other interesting differences are found to exist in the behaviour of the kathode and the anode, in the case of the mercury arc. The arc obtained when amalgams and pure alkali metals are used in place of mercury is shown to behave in a manner completely analogous to the mercury arc. Of considerable interest are the various methods by which it is shown that an alternating current mercury vapour arc may be started. Their investigation has led the author to important improvements in the design of vapour arc rectifiers for both monophase and polyphase currents.

Atmospheric Radioactivity.

S. J. ALLAN, in *The Philosophical Magazine* for February, describes a number of experiments which, in conjunction with others previously described by Prof. Rutherford and himself, show that the excited radioactivity from the atmosphere is in many ways analogous to that obtained from thorium and radium. The author arrives at the conclusion that the observed radioactivity of snow and rain must be due to the adherence of radioactive matter present in the atmosphere.

The Energy of Radium.

THE thermal energy radiated by one gramme of radium has been shown to be 80 small calories per hour, or a quantity of heat capable of melting an equal weight of ice in one hour. This energy works out at about ·00129 b.h.p., of which a very small fraction, however, could be utilised for mechanical purposes, as the difference of temperature which gives rise to this flow of heat is very slight, being only about 3 degrees C. Granted, therefore, that a machine could be invented which could work between such narrow limits of temperature, the efficiency of such would certainly be much below 10 per cent.

Motion of Radium in the Electric Field.

DR. J. JOLY, in the March number of *The Philosophical Magazine*, describes the very curious observation made by him that a delicately suspended disc, coated on one side with radium bromide of high activity, is repelled by an electrified body brought up to the side coated with radium, but attracted when the electrified body is brought up to the uncoated side. The effect is the same whether the electrification of the body is positive or negative.

Further investigations appear to show that the effect was one of induction, the attractive charge being dissipated by the ionising influence of the α-rays, while the repellant charge remained to exert a mechanical effect upon the disc.

Structure of Atoms.

THE March number of *The Philosophical Magazine* opens with a very interesting and important paper by Prof. J. J. Thomson on this subject. An atom may be supposed to consist of a number of particles moving about in a sphere of uniform positive electrification. The problems to be solved are the determination of the arrangement of the particles within the sphere; and the properties thus conferred upon the atom. The particles will be constrained by the criterion of stability to arrange themselves in a series of concentric shells. The mathematical difficulties of dealing with the problem in the general form are very great, and the author therefore assumes that the arrangement is in a plane, giving a series of concentric rings. This problem admits of a definite solution, which is obtained, and applied to the cases of varying numbers of particles, and it can be seen that this restriction will not cause any essential alteration in the properties of the atom so constituted. Among the extremely interesting results attained, we may especially note the demonstration of the possible existence of secondary groups of particles within the atom, and the explanation of the phenomena of radioactivity by the demonstration that systems may exist which are stable so long as the particles are rotating with an angular velocity exceeding a certain critical value, but become unstable as soon as the angular velocity falls below this critical value.

Ionisation produced in Gases by Rontgen Rays.

R. K. McCLUNG, in *The Philosophical Magazine* for February, describes a series of experiments which appear to show definitely that the amount of ionisation produced by Röntgen rays in a given volume of a gas, kept at a constant density, is independent of the temperature, a conclusion at variance with that arrived at by Prof. Perrin in 1897.

Power Factor Meter.

THREE instruments are usually required for measuring the power factor in an alternate current circuit: these are a voltmeter, ammeter, and wattmeter. The method gives rise to errors as high as 4%. At a recent meeting of the Société des Electriciens, M. Chaumat described a new instrument invented by M. Routin, which gives the angle the cosine of which is the required power factor. This electrogoniometer, as M. Routin calls it, can only be used with triphase current. It was tested on a circuit comprising a small triphase generator, a wattmeter, and the primary winding of a small transformer. The calculated power factors and those indicated by the instrument were fairly in agreement, and considering that the instrument used was the first of its kind, the results were very satisfactory.

Radium Emanations.

PROFESSORS E. Rutherford and H. T. Barnes, in a communication to the February number of *The Philosophical Magazine*, describe a series of investigations carried out with the view of determining the relation between the heat emission of radium and its radioactivity. The authors arrive at the conclusion that the time-variation of the heating effect of each of the radioactive products is the same as the time-variation of the activity, a result which shows that the heat emission of radium is an accompaniment of the successive changes occurring in it.

It is pointed out that the radium emanation behaves like a heavy gas. The assumption that the molecule of the emanation is 100 times as heavy as the molecule of hydrogen would lead to the conclusion that one pound weight of the emanation would radiate energy at the initial rate of from 10,000 to 100,000 horse-power, and, while the heating continued, would emit energy of between 1,400,000 and 15,000,000 horse-power-hours.

Lord Kelvin contributes some observations on the nature of the radium emanations to the same number of the magazine, in which he applies his atomic resuscitation of the doctrine of Aepinus to the explanation of the phenomena observed. He inclines to the belief that the radium, while giving out heat to the surrounding ponderable matter, is itself receiving an influx of energy from the impact of etherial waves.

He mentions in an editorial note the communication to him by Lord Blythswood of the interesting discovery that cambric is rendered quite rotten by an exposure for two or three days to radium emanations.

Further Facts on the Luminous Phenomena due to Ozone and Radium.

F. Richarz and R. Schenk some time ago, communicated to the Berlin Academy of Sciences, the observation that Sidoblende (zinc-sulphide) becomes luminescent in a stream of ozone. In a paper recently read before the same Academy, the experimenters record some other cases of luminescence due to ozone. While white phosphorus will glow even in air, red phosphorus shows a luminescence only in ozone, this luminescence being of a feeble intensity in the case of ordinary red phosphorus, while that of phosphorus derived from a phosphorus tribromide solution is very strong. As regards the disozonising effect of sidoblende and red phosphorus, a stream of ozone left to itself, was not capable of acting on a steam jet, but would act strongly after coming in contact with either of these substances. Among other substances showing a slight incandescence in ozone, there is vitrious arsenic acid, while a drop of turpentine oil shows a strong luminescence. The experimenters also noted that the finger held into a stream of strongly ozonized oxygen, escaping into the air, as well as wool, paper, linen, cotton, would show a luminescence, due most likely to the adherence of ozone to such bodies.

The Conditions Controlling the Production of Electric Arcs.

At a recent meeting of the Physical Section of the Russian Physico-Chemical Society, W. Mitkiewicz recorded some experiments on the conditions necessary for the production of electric arcs. The author has observed the so-called Edison effects (*i.e.*, the fact that negative electric charges are lost more rapidly from a heated body), not only in a vacuum, but also in hydrogen under atmospheric pressure between an incandescent carbon filament and a cold cylinder of the same substance. The current corresponding to a negative dispersion of electricity undergone by the wire proved 2.000 times stronger than the current of opposite direction (viz. about 0·4 amp., and 0·002 amp. respectively per sq. cm. of the surface of the wire). On the basis of this experience, the hypothesis that electric arcs are made up of a flux of electrons issuing from the negative electrode becomes highly probable. The high temperature of the negative electrode of the arc is mainly due to the flux of heat issuing from other portions of the arc, being at much higher temperatures. Regarding the positive ions, the author thinks that they will convey only relatively low amounts of energy to the negative electrode surface. Electric arcs will be produced quite spontaneously between two electrodes which do not touch one another, in the case of their ends being brought to a white heat in a stream of oxygen. If the carbon electrodes be brought to a white incandescence by the action of the arc, and the current being interrupted, either one of the electrodes be replaced by another electrode, being at the temperature of the surrounding atmosphere, the arc will be produced spontaneously without any contact only in the case of the electrode which remains incandescent being the cathode. These experiments go to show the correctness of the hypothesis that a sufficient height of the temperature of the cathode is the condition necessary for producing and maintaining the electric arc. On this hypothesis a large number of phenomena observed on electric arcs, especially in the case of a periodical extinction and restarting, may well be accounted for.

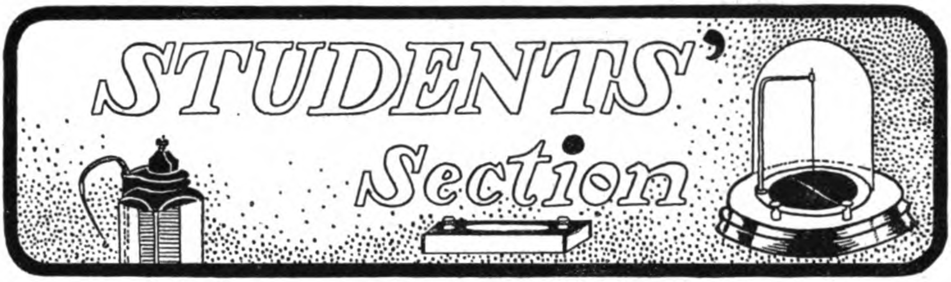
Action of Radium on Glass, Quartz and other Bodies.

Glass is known to be blackened under the influence of radiumrays, the same phenomenon being observed in the case of quartz. The colouration produced by radium will disappear, not only under the influence of a heating, but also at ordinary temperatures. N. Georgiewski has investigated, by a photometric method, the absorption of glasses and of quartz, coloured by radium rays, as well as its diminution with time, this diminution being represented by a logarithmic curve. The author describes his experiments made on quartz, mica, gypsum and other bodies, showing the alteration of the optical properties of these materials as occurring under the influence of radium rays. Mica, placed between crossed nickel prisms, shows an alteration in the chromatic polarisation in the portion which formerly was exposed to the action of radium rays, this alteration disappearing as soon as the specimen is heated. Gypsum and fluorspar, while showing the same alterations of the optical properties, are not blackened under the influence of radium rays.

Thermo Electric Forces and Heated Wires.

In order to test some experiments made by Mr. Egg-Sieberg as far back as 1900, M. F. Schneider, in a paper recently published in the *Elektrot. Zeitschrift*, made the following experiments.

After coating one half of a long and thin iron wire with a thick layer of asbestos ribbon, the end of the asbestos was heated by means of a gas flame, when the steeper temperature gradient was found in the direction of the free wire, whereas the current would flow from the flame to the coated wire. The potential difference, after increasing gradually, reached a maximum of about 0·5 volts after a time ranging between one and two hours, the wire being heated up to about 1,000°. On allowing the wire to cool down and heating it again, the potential difference was found immediately to reach its maximum value. An iron wire, being clamped between two iron jaws and heated, would give rise to a current flowing from the heated place to the portion cooled by the iron jaws. An iron wire heated by a flame and cooled suddenly on one side of the flame by means of two iron jaws, would show a current flowing from the cooled to the heated places. Two iron wires of the same material but of different diameters being united mechanically, would give rise to a current flowing from the thin to the thick wire, on the connecting points being heated.



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of *The Electrical Magazine* feels that something more is wanted, and the Associate Editors, will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

Problems in Dynamo Design.—II.

By ELLIS H. CRAPPER, M.I.E.E.

WHEN fully excited, the values of the induction **B**, in the various parts of the magnetic circuit of a dynamo, and the mean lengths of path l of the magnetic flux, are as given below:

Magnet cores, high permeability cast steel (two in a circuit)	$l = 30$ cms;	$\mathbf{B} = 13{,}000$.
Magnet yokes, high permeability cast steel	$l = 40$ cms;	$\mathbf{B} = 10{,}000$.
Air gap (flux crosses twice in a circuit)	$l = 7$ mms;	$\mathbf{B} = 7{,}000$.
Armature teeth (flux passes through two groups each)	$l = 25$ mms;	$\mathbf{B} = 20{,}000$.
Armature core, charcoal iron sheets	$l = 30$ cms;	$\mathbf{B} = 10{,}000$.

The mean length of a turn of the shunt winding is 80 cms, and the E.M.F. measured at the ends of the coils on a pair of limbs is 100 volts. What would be the size of wire required for a shunt winding, neglecting any allowances for armature reaction? (City and Guilds Examination in Electric Lighting and Power Transmission, Honours, 1902).

This problem has been chosen for the purpose of illustrating how to determine the number of ampère-turns required for the excitation of a continuous current dynamo when the respective lengths of the various parts of the magnetic circuit and the corresponding values of the induction are known. It is assumed that the elementary principles of the magnetic circuit are understood; it is important, however, to study how these principles are applied in practice in the design of dynamos. The determination of the excitation is much simplified by dealing with the separate portions of the magnetic circuit individually, as indicated by the fundamental formula proposed by Drs. J. and E. Hopkinson in 1886. This well-known formula may be stated as follows:

$$1{\cdot}257\ \mathrm{CS} = \mathbf{N}\left\{\frac{l_a}{\mu_a A_a} + \frac{2l_g}{A_g} + \frac{2l_m v}{\mu_m A_m} + \frac{l_y v}{\mu_y A_y}\right\}$$

in which CS = ampère-turns; **N** = total magnetic flux through the armature; l, μ, and A denote respectively the length, permeability, and area of cross-section (in sq. cms.) of the separate portions of the machine; the sections of armature, air-gap, magnetic core, and yoke being denoted by the small letters a, g, m, and y respectively; v represents the leakage co-efficient. The fundamental formula may be written as follows:

$$1.257\ \mathrm{CS} = \left(\mathbf{N} \times \frac{l_a}{\mu_a A}\right) + \left(\mathbf{N} \times \frac{2l_g}{A_g}\right) + \left(\mathbf{N} \times \frac{2l_m v}{\mu_m A_m}\right) + \left(\mathbf{N} \times \frac{l_y v}{\mu_y A_y}\right)$$

Since $\frac{l_1}{\mu_1 A_1}$ = reluctance, which may be denoted by R.

$\mathbf{N}_1 \times \frac{l_1}{\mu_1 A_1}$ = difference of magnetic potential (or magnetising influence) required to send the flux $\mathbf{N}_1$ through a certain portion of the magnetic circuit, l_1 cms in length.

Let Ω_1 = this difference of magnetic potential

$$= \mathbf{N}_1 \times \frac{l_1}{A_1 \mu_1}.$$

Summation of the separate differences of magnetic potential gives

$$\Omega = \Omega_a + \Omega_g + \Omega_m + \Omega_y$$
$$= \text{total magneto-motive force (M.M.F.)}$$
$$= 1{\cdot}257 \text{ CS.}$$

Thus, as in the electric circuit, a specific difference of potential (P.D.) has to be maintained between two points in the circuit in which there is a definite flow of electricity or current, so in the magnetic circuit there must be a definite difference of magnetic potential (Ω_1, say) maintained between two points in that circuit in which there is a flow of magnetic lines of force.

But $$\mathbf{N}_1 \times \frac{l_1}{\mu_1 A_1} = \frac{\mathbf{B}_1}{\mu_1} \times l_1 = \mathbf{H}_1 \times l_1$$
$$\therefore \quad \Omega_1 = \mathbf{H}_1 \times l_1.$$

This result implies that if we know $\mathbf{H}_1$—*i.e.*, the magnetising force $\mathbf{H}_1$ required per centimetre length to send a given flux-density, $\mathbf{B}_1$, through a magnet core—the total magnetising influence, Ω_1, is found by multiplying $\mathbf{H}_1$ by the length l_1 in centimetres. The value of $\mathbf{H}_1$ is obtained from the magnetising curve for the material used either in C.G.S. units or in ampère-turns. If $\mathbf{H}_1$ be given in C.G.S. units, then

$$\Omega_1 = 1{\cdot}257 \text{ CS} = \mathbf{H}_1 \times l_1$$

but, if the magnetising influence be desired in ampère-turns, Ω_1^1 (say)

$$\Omega_1^1 = \frac{\Omega_1}{1{\cdot}257} = \frac{\mathbf{H}_1 \times l_1}{1{\cdot}257}$$
$$= (0{\cdot}8\ \mathbf{H}_1) \times l_1$$

($0{\cdot}8\ \mathbf{H}_1$) is known as the "function of $\mathbf{B}$," and is usually written $f(\mathbf{B})$. In Figs. 1, 2 and 3 the magnetising force is given both as ampère-turns and in C.S.G. units. In practice considerable experience is necessary before one can decide upon the dimensions of, and permissible flux-density, $\mathbf{B}_1$, for, the various parts of the magnetic circuit of a dynamo. In the problem under consideration, these quantities are fixed, and the solution is a simple application of the principles just explained.

Attention is drawn to the fact that the formula introduced in Problem I. (see *The Electrical Magazine* for March) may again be used to determine the size of the wire required for the shunt-winding provided the excitation be given in ampère-turns; we shall therefore determine Ω_1^1 in ampère-turns in this solution. The total number of ampère-turns is the sum of five component parts, as indicated by the formula

$$\Omega_{at} = \Omega_m + \Omega_y + \Omega_g + \Omega + \Omega_a$$

in which Ω_t denotes the ampère-turns required for the armature teeth, the other portions of the magnetic circuit being distinguished by the letters *m*, *y*, *g* and *a*, as explained above.

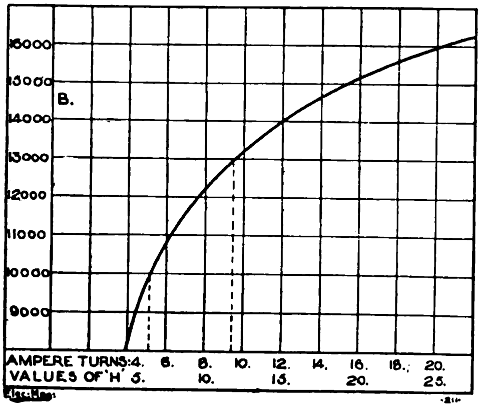


FIG. 1.

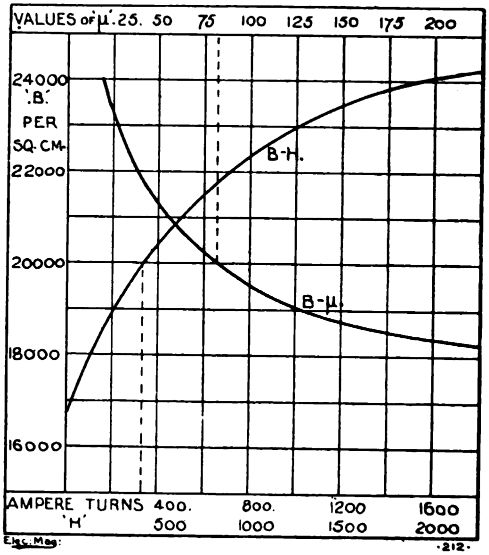


FIG. 2.

Determination of Ω_m.—Fig 1 gives that portion of the magnetisation curve of Edgar Allen's high permeability cast steel (a suitable material for the magnet cores and yoke in this case) required in this determination. Now,

$$\Omega_m = f(\mathbf{B}_m) \times 2l_m$$
$$= f(13{,}000) \times (2 \times 30).$$

$f(13{,}000)$ is given in Fig. 1, by the vertical dotted line from the point of the magnetisation curve which represents a flux-density, 13,000, which is obviously 9.6, therefore

$$\Omega_m = 9{\cdot}6 \times 60 = 576 \text{ ampère-turns.}$$

Determination of Ω_y. Similarly

$$\Omega_y = f(\mathbf{B}_y) \times l_y$$
$$= f(10{,}000) \times 40$$
$$= 5{\cdot}1 \times 40$$
$$= 204 \text{ ampère-turns}$$

Note, $f(10{,}000) = 5{\cdot}1$ (see Fig. 1).

Determination of Ω_g. The excitation required for the air-gaps is determined as follows: Since the permeability of air is unity, $\mathbf{B}_g = \mathbf{H}_g = 7{,}000$, but

$$\mathbf{H}_g = 1{\cdot}257 \frac{(\text{CS})_g}{2l_g}$$

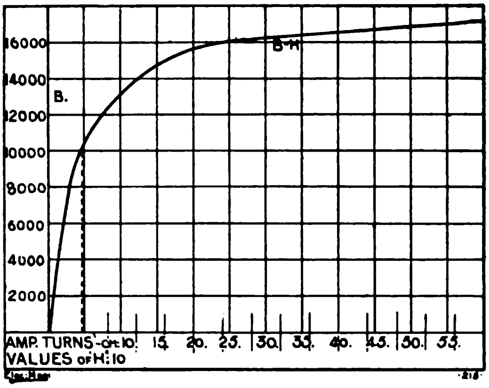


FIG. 3.

$$\therefore (CS)_g \text{ or } \Omega_g = \frac{\mathbf{H}_g \times 2l_g}{1{\cdot}257} = 0{\cdot}8\ \mathbf{H}_g \times 2l_g$$
$$= 0{\cdot}8 \times 7{,}000 \times 2 \times 0.7$$
$$= 7840 \text{ ampère-turns.}$$

Note, 7 mms. = 0·7 cm.

Determination of Ω_t. As will be observed, the flux-density allowed in the teeth of the armature is very high, *i.e.*, 20,000 lines per sq. centimetre, and the **B—H** curve for sheet-iron at high flux-densities (as given by Hobart) given in Fig. 2 must be used. Thus

$$\Omega_t = f(\mathbf{B}_t) \times 2l_t$$
$$= f(20{,}000) \times (2 \times 2{\cdot}5)$$
$$= 330 \times 5 = 1{,}650 \text{ ampère-turns.}$$

Note, $f(20{,}000) = 330$ (see Fig. 2).

Determination of Ω_a. For lower flux-densities as adopted for armature cores, the **B—H** curve (Fig. 3) for sheet-iron should be used, thus

$$\Omega_a = f(\mathbf{B}_a) \times l_a$$
$$= f(10{,}000) \times 30$$
$$= 4{\cdot}8 \times 30 = 144 \text{ ampère-turns.}$$

Note, $f(10{,}000) = 4{\cdot}8$ (see Fig. 3).

$$\therefore \Omega_{at} = 576 + 204 + 7{,}840 + 1{,}650 + 144$$
$$= 10414 \text{ ampère-turns.}$$

Determination of the size of wire. The formula given in Problem I. *(The Electrical Magazine*, March) is

$$d \text{ (mils.)} = \sqrt{\frac{12 CS l_m}{E}}$$
$$= \sqrt{\frac{12 \times 10{,}414 \times \frac{80}{2{\cdot}54 \times 12}}{100}}$$
$$= \sqrt{3{,}280} = 57{\cdot}2 \text{ mils.}$$

∴ diameter of bare wire = 0·0572 inch.

"The Electrical Magazine" is not only specially valuable to students by reason of this section, but also for its other sections which particularize on subjects inseparable from the aims and ultimate objects of all students of Electrical Engineering. Ask your professor for the special terms on which we supply the Magazine.

THE FOUNDATIONS OF ELECTROMAGNETISM.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p.* 296).

In order to explain the view advanced by Maxwell, we may return to the example just considered, *viz.*, that of a short straight wire moving with *accelerated* motion across a magnetic field. The current flowing along the wire does not, according to Maxwell, end at its extremities, but is continued through the dielectric (air-space) surrounding the wire, and the system of stream-lines issuing from one end of the wire and curving round to enter the other end is precisely analogous to the system of lines of magnetic force proceeding from one end of a magnet to the other (see Fig. 3). Now a dielectric such as the air-space surrounding the moving wire is incapable of conducting a *steady* current; but it is capable of transmitting a *varying* current. As soon as the wire begins to move, and a current to flow along it, electric charges accumulate at the ends of the wire, and between these charges there are, in the surrounding dielectric, lines of electric force stretching across from the positive charge at one end of the wire to the negative charge at the other. The surrounding dielectric is the seat of a field of electric force; the dielectric is in some way strained or polarised. So long as the current continues to flow in the wire, the charges over the ends of the wire are altering, and as a consequence the field of electric force surrounding the wire is also altering. Now this alteration in the electric field intensity is, in accordance with Maxwell's view, regarded as constituting a flow of electric current through the dielectric, the stream-lines coinciding with the lines of electric force. The current is absolutely continuous through the entire surface of the wire, so that the amount of current flowing towards any portion of the surface through the copper is precisely equal to the amount of current flowing away from the same portion into the surrounding air-space. In order to make this quite clear, we append a diagram (Fig. 4), showing a tube of flow (bounded by stream lines) inside the wire, and continued as a tube of flow through the surrounding air-space (the stream-lines bounding this latter portion of the tube are coincident with the lines of electric force). In order to distinguish the flow of current through a conductor from its flow through a dielectric, Maxwell introduced the term *displacement current* to denote the latter. A displacement current produces a magnetic effect similar to that due to any ordinary conduction current. A displacement current occurs wherever there is an electric field of *varying intensity*.

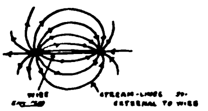


FIG. 3.

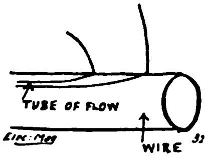


FIG. 4.

According to this view, which is now universally adopted, the flow of an electric current is a circuital phenomenon *in every possible case*: so that if we consider any closed surface, which may pass partly through conductors, and partly through insulators, then the algebraical sum of all the currents entering the closed surface is zero.

The same principle of circuitation applies to *Magnetic fluxes*. If we consider any closed surface, which may lie partly in a magnetic and partly in a non-magnetic medium, then the total number of lines of magnetic induction entering the closed surface is equal to the total number leaving it. In this respect, *magnetic induction* differs entirely from *magnetic force*. The number of lines of *force* entering any closed surface need not necessarily be the same as the number leaving it. For example, if we consider (Fig. 5) the case of a very long thin magnet of pole-strength P, and take for our closed surface a sphere of radius r surrounding the north pole, then the value of the magnetic *force* at every point of this spherical surface is practically the same, *viz.*, P/r^2 (the south pole of the magnet being assumed to be so far away as to exert no appreciable effect on the magnetic force within the sphere surrounding the north pole), whether we consider a point on the surface lying outside or one lying inside the magnet. In the latter case, we have to imagine a unit pole introduced into a long cylindrical cavity drilled through the magnet parallel to its length, as shown in Fig. 6; and it is evident that in such a cavity the force acting on the unit pole will have the same value as it has just outside the magnet, *viz.*, P/r^2. The direction of the magnetic force being everywhere *outwards*, it follows that the total number of lines of *force* leaving the surface is $\frac{P}{r^2} \cdot 4\pi r^2 = 4\pi P$. And since there are no lines of *force* entering the surface, we see that the principle of circuitation does not, in this special case, apply to magnetic force. The matter is entirely altered, however, if, instead of magnetic force, we consider magnetic induction. In external space, these two quantities have the same numerical value, *viz.*, P/r^2, and if a = cross-sectional area of magnet, or portion of the spherical surface intercepted by magnet, then the number of lines of magnetic *induction* leaving the portion of the spherical surface external to the magnet is $\frac{P}{r}\left(4\pi r^2 - a\right) = \left(4\pi - \frac{a}{r^2}\right)P$. In order to determine the number of lines of induction through the portion of the spherical surface intersecting the magnet, we have to imagine the magnet cut across (Fig. 7) at the area of intersection, and a unit magnetic pole introduced into the crevasse so formed. The force acting on the unit pole when placed in the narrow crevasse is, by definition, the induction (or the number of lines of induction per sq. cm.) over the area of cross-section of the magnet. Now the total force acting on the unit pole is made up of (1) the *inward* (with respect to spherical surface) force due to the two opposite poles, each of pole-strength P, on the walls of the crevasse, the value of this force being $4\pi P/a$; and (2) the *outward* force, of amount P/r^2, due to the north end of the magnet. The resultant force on the unit pole when placed in the crevasse is thus $\frac{4\pi P}{a} - \frac{P}{r^2}$, and this is, by definition, the number of lines of magnetic induction per sq. cm. of cross-section of the magnet. The total number of lines of induction over the cross-section, or the total magnetic flux *entering* the spherical surface, is therefore $\left(\frac{4\pi P}{a} - \frac{P}{r^2}\right) \times a = \left(4\pi - \frac{a}{r^2}\right)P$, and is thus identical with the expression found above for the total number of lines of induction leaving the spherical surface over the portion of it which is external to the magnet. We must think of a narrow sheaf of lines of induction as entering the spherical surface through the magnet, and on reaching the north pole spreading out radially, and then leaving the spherical surface through the space external to the magnet.

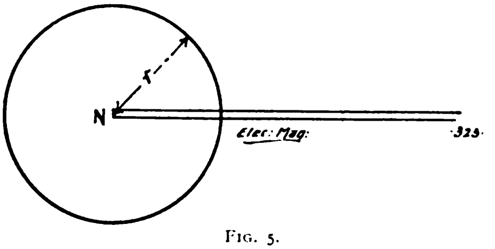


FIG. 5.

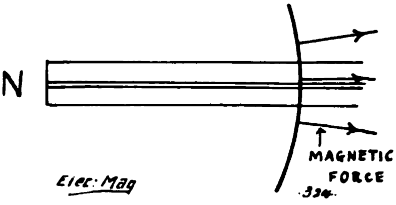


FIG. 6.

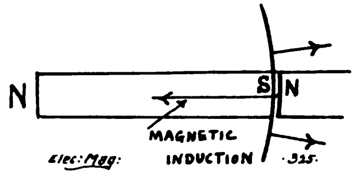


FIG. 7.

DEFINITION OF RESISTANCE AND OHM'S LAW.

The subject of Ohm's *law* is dealt with in so extremely slovenly a manner in a large number of elementary books that it seems desirable to draw special attention to it here. Consider a steady current i flowing through a conductor between whose ends is maintained a potential difference V (the conductor is supposed not to contain any E.M.F.'s). The ratio $\frac{V}{i}$ is defined as the *resistance* of the conductor, and if we use r to denote this resistance, then by definition $r = \frac{V}{i}$. It is particularly to be noted that this equation does not, so far, represent any *law*, but is merely the symbolical expression of a *definition*. Now, if we change the value of the potential difference to V_1, obtaining a new value i_1 for the current, then there is absolutely no *a priori* reason why the ratio $\frac{V_1}{i_1}$ should remain unaltered; we might, as before, still speak of this ratio as the new resistance r_1 of the conductor corresponding to the new current i_1, so that $r_1 = \frac{V_1}{i_1}$; but we have no right to *assume* that r_1 is identical with r. It is, in fact, not inconceivable that corresponding to each value of the current the conductor has a *different* resistance, the resistance being in each case *defined* by the ratio $\frac{\text{P.D.}}{\text{current}}$. What the *law* of variation of resistance with current actually is can only be decided by *experiment*. Now, extremely careful experiments have shown that, provided the *physical state* of the conductor remains unaltered, the quantity which we define to be the resistance of the conductor for each current is independent of the value of the current—*i.e.*, has the *same* value for all currents. This purely experimental result is *Ohm's law*. A few words may not be out of place as to what is meant by the physical state of the conductor. Primarily, this expression refers to the temperature of the conductor; a change of temperature being in general found to produce a change of resistance. But the resistance is also influenced by other physical changes—such as a change in the mechanical stress acting on the conductor; thus, tension or compression or torsion applied to a conductor in general produce appreciable changes in its resistance.

Not unfrequently, Ohm's law is stated to be contained in the equation $r = \frac{V}{i}$. When correctly interpreted, this statement is, no doubt, true; but it is open to the objection that the mere *definition* of resistance, which does not represent any *law*, is symbolically represented by the same equation. A far more satisfactory way of expressing the matter in connection with the equation is to say that Ohm's law asserts the *constancy* of r in the equation $r = \frac{V}{i}$, no matter how V and i may be varied, provided the physical state of the conductor remains unaltered.

* * *

THE ALTERNATING CURRENT SERIES MOTOR.

The alternating current series motor, which is attracting so much attention both at home and abroad, is by no means a new problem. The characteristic principles of this type were known years ago, but on account of the high frequency currents employed at that time the results were far from satisfactory. During the process of evolution, however, high frequencies have given place to low, and the problem has been revived and is in a much healthier condition than formerly. The pure single-phase series motor is in principle and theory on all fours with the well-known continuous current series-wound motor, and like it possesses properties which make it a satisfactory railway motor. The direct-current series motor does not reverse by the reversal of the current at its terminals, but only when the reversal is as between armature and field. If such a machine is fed with an alternating current at one cycle per second, the same relation holds true, and so on up to the point where, with increasing frequency inductance and parasitic currents, render it defective.

An explanation of the operation of the single-phase series motor has recently been given before the Electric Club, Pittsburg (*Electrical Review*, N.Y., 6/2/04), by Mr. F. D. Newbury, who treats the subject from the point of view of the following characteristic phenomena:—

(1) The electrically generated electro-motive force which is set up in the armature winding by the alternating magnetic field, in addition to the E.M.F. generated by the rotation of the armature.

(2) The local armature current, which circulates in the armature coils, short-circuited by the brushes, due to the E.M.F. of (1).

(3) The iron loss occurring in the entire magnetic circuit (1) due to the alternating magnetic field.

(4) The counter E.M.F. of the field coils which exists between the turns of the field coils.

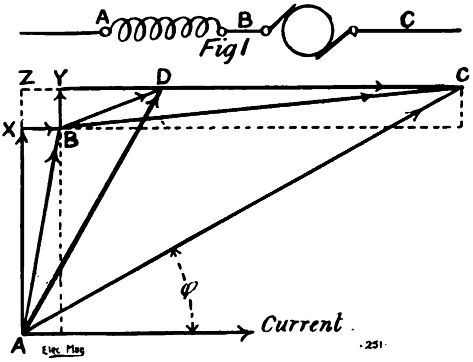


Fig. 1. A. C. Series Motor.

The voltage diagram is given for the motor circuit, and is shown in Fig. 1.

Starting at one terminal A and with the direction of current indicated, the field voltage line is AB. It is made up of two components, the E.M.F. neutralising the E.M.F. of self-induction AX, and the E.M.F. XB representing the losses supplied by the field. AX = reactive component and XB = energy component, and XB is so small relatively to the reactive component AX that there is nearly 90° phase relationship between the field voltage AB and the current. BC is the armature voltage, of which the reactive and energy components are respectively BY and YC. YC is great compared with BY, since it represents the energy transformed into mechanical work, in addition to the armature losses. It will also be noted that the armature reactive E.M.F. is considerably less than the field reactive E.M.F. The voltage of supply is, of course, the resultant of the field and armature pressures AB and BC, and is represented by the line AC. As shown in the figure, AC is also the resultant of the sum of the two inductive components (*i.e.*, AZ = AX + BY), and the sum of the two energy components (*i.e.*, ZC = XB + YC).

The angle ϕ represents the phase relationship between the pressure of supply and the current under running conditions. The power factor on high speed is greater with small currents than with heavy currents, as the inductive E.M.F. of the field is less. The alternating current series motor serves a very interesting illustration of the fact, true of all motors, that certain losses are supplied directly from the electrical energy, and others, indirectly, by the mechanical energy produced by the motor.

COMPARISON OF LOW RESISTANCES.

The following is a simple method of comparing low resistances, and is given by Mr. Frank Wenner in *The Physical Review*, Nov., 1903.

In Fig. 1 let AA^1 and BB^1 be the conductors, whose resistances are to be compared. These are joined by conductors AB and A^1B^1. Two points X and Y, on BB^1 are connected to the terminals of the battery. The galvanometer is connected to a point Z on BB^1, and to a point W on AA^1 such that the bridge is in balance. Move the connections X, Y, and Z in the same direction through equal resistances to points X^1, Y^1, and Z^1.

To again balance the bridge the connection W must be moved to a point W^1 such that the resistance of AA^1 between W and W^1 is equal to the resistance of BB^1 between X and X^1, Z and Z^1, or Y and Y^1. The student should endeavour to prove the principle of this method, which is that the resistance in each of the four arms of the bridge is increased and decreased by the same amount.

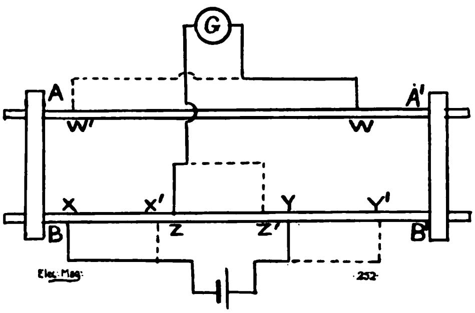


FIG. 1. COMPARISON OF LOW RESISTANCES.

FROM PROFESSOR to Student.

Under this heading we shall deal with the queries of Students on matters directly relating to the science and application of electricity. Letters addressed to "The Associate Editor, Students' Section," should be received before the 1st of the month, if replies are needed in the next issue. A number of replies are unavoidably held over till next month.

"Plodder."—A knowledge of Elementary Trigonometry is essential if you wish to understand Alternating and Polyphase Currents. Lock's "Elementary Trigonometry" (Macmillan & Co.) may be recommended as a reliable text-book. For the electrical part of the subject read Hay's "Alternating Current Working," published by Biggs & Co.

"Malbert."—The formula $R=\frac{0·4343\ t}{\text{Cap}\ (\text{Log}\ \frac{V}{v})}$ is difficult to deduce by ordinary Algebra, but may be readily obtained by the application of the Calculus.

As you are probably aware, it is the formula which is employed in the method of measuring very high resistances by *loss of charge*, which consists in observing the time taken for a charged cable to fall in potential by a known fraction. Briefly, the following is an outline of the theory of the method. Let C be the capacity of an insulated conductor, and R the dielectric or insulation resistance of the cable. Upon charging this cable, its initial potential rises to V, which is a measure of the quantity of electricity that has been given to it. If the insulation were perfect, the charge would remain constant, and therefore V would remain constant. If a discharge take place through the insulation resistance R, the quantity of electricity leaking will be proportional to the potential and inversely proportional to the resistance. But the quantity escaping will vary from instant to instant, since the potential will diminish as the charge gets less. Thus, in t seconds let the potential fall to v, which becomes $v—\delta v$ after a further small interval of time δt; the time rate of change of potential during this small period is $\frac{\delta v}{\delta t}$. Since quantity of electricity = capacity × potential, therefore the time rate of charge is $C\times\frac{\delta v}{\delta t}$, which is the rate of leakage through the insulation. Consequently,

$$-C\times\frac{\delta v}{\delta t}=\frac{v}{R}\ \text{(by ohms law)},$$

$$\text{and}\ \frac{\delta v}{v}=-\frac{\delta t}{CR}$$

By integration we get

$$\log_e\frac{v}{V}=-\frac{1}{CR}t+k$$

in which k is the constant of integration.

When t is zero $v=V$ (initial potential), and

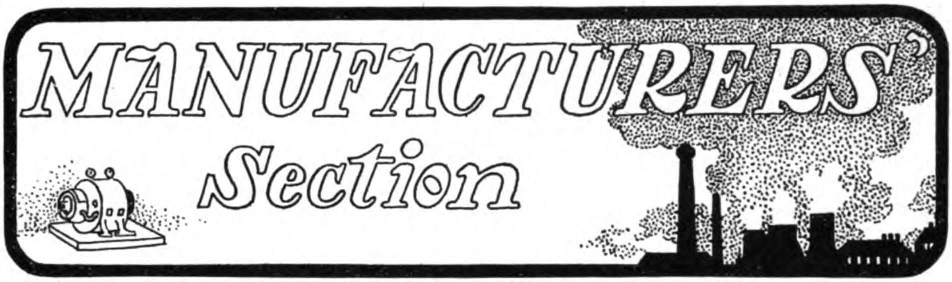
$$\log_e v—\log_e V=-\frac{t}{CR}$$

$$\therefore R=\frac{t}{C\ (\log_e\frac{V}{v})}$$

Changing from Naperian to ordinary logarithms we have

$$R=\frac{t}{2·303\ C\ \log\frac{V}{v}}$$

$$=\frac{0·4343\ t}{C\ \log\frac{V}{v}}$$



MANUFACTURERS' Section

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be *original* and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

Erroneous Thermometer
Reading in Dynamo and Motor Tests.

By W. NOBLE TWELVETREES,
M.I.M.E. A.M.I.E.E., &c.

It is well-known that the most accurate means of determining the rise of temperature of the field windings of a continuous current machine is by noticing the increase in the resistance of the winding. When observations are made by thermometer, the results are invariably below the actual values, however carefully the bulbs may be protected to minimise the radiation of heat, and, further, the readings necessarily vary with the position of the thermometer. These points are well illustrated in the course of a recent paper by Professor C. F. Smith,[*] where some temperature tests of small dynamos and motors are described. One interesting diagram in this paper contains three curves obtained as follows: The shunt windings of a small bipolar motor were connected to the 100 volt mains, and readings of the current flowing through the coils were taken every ten minutes; the voltage at the terminals being also observed and the resistance of windings calculated. Simultaneous readings were taken with mercurial thermometers having their bulbs in contact with the windings, one thermometer being placed outside one of the magnet limbs, and the other between the magnet limbs and against the inner surface of one limb. The final readings of the latter thermometer after 202 minutes were fully 5 deg. C. below the average temperature of the coils as determined on the basis of increase in resistance. Assuming the average temperature to be the mean between the hottest and the coolest layers, the maximum temperature would be about 10 deg. C. above the temperature indicated by a thermometer applied to the outside of the coil. In the test to which we refer, the readings were taken with the armature stationary, and with the machine at work the temperature difference would, of course, be considerably greater.

As a further illustration of the errors due to thermometric readings, Professor Smith gives a diagram showing curves obtained by plotting the results afforded by two thermometers placed respectively between the limbs, and on the outer side of one limb, of a bi-polar motor. Each thermometer was carefully protected, and a constant potential was applied to the magnet windings. In this case, the final readings of the thermometers differed by nearly 21 deg. C., and it should be remembered that a little carelessness in wrapping the thermometer bulb during a test might very easily cause a still greater error than would be incurred by taking either of the above mentioned curves to represent the true temperature of the coils. The measurements to which we refer are, of course, merely the average temperature of all the windings.

---

[*] "Dynamo and Motor Testing," by Professor C. F. Smith, Wh Sc., A.M.I.E.E. A paper read before the Civil and Mechanical Engineers' Society, Session 1903-4.

ELECTRIC LOCOMOTIVES.

We illustrate on this page four new types of electric locomotives lately placed on the market by the Brush Electrical Engineering Co., the Electric Construction Co., and the Société Alsacienne, Belfort, France. The first of these, illustrated in Fig. 1, is fitted with one 1002B motor driving through gearing on to one axle. This motor is of the drum armature, four-pole, iron clad type, wound for a line pressure of 500 volts. With single reduction gear the locomotive is capable of drawing, exclusive of its own weight, the following gross loads at 9½ miles per hour :—

On the level	63 tons.
On an incline of 1 in 100	24 „
„ „ „ „ 1 in 60	14 „
„ „ „ „ 1 in 30	5 „

With double reduction gear, the motor gives a greater drawbar pull, at naturally a lower speed. The motor is operated from the cab by a controller of the ordinary tramway type, fitted with the necessary resistances. The locomotive is constructed principally of steel sections with sheet steel covers, and is fitted with buffing gear, similar to main line railway wagon stock. The wheels are coupled to obtain the total adhesions and have cast iron brake blocks operated from the interior of the cab.

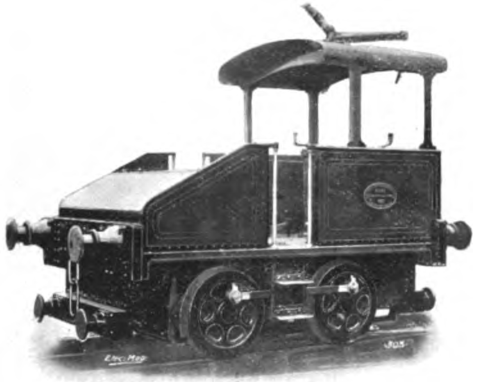


Fig. 1. Brush Locomotive.

A locomotive of similar type but with two motors in parallel, is capable of drawing the following loads at 9½ miles per hour : —

On the level	133 tons.
On an incline of 1 in 100	54 „
„ „ „ „ 1 in 60	36 „
„ „ „ „ 1 in 30	18 „

The wheels are not coupled in this engine, as no advantage is to be gained thereby when each axle has a separate motor.

The locomotive illustrated in Fig. 2 is one designed by the Electric Construction Co., of Wolverhampton, with the object of minimising the difficulties of haulage both in mines and in tunnel work. The chief difficulty is the limited size of tunnels in which the locomotives operate, and in the contract for which this type of engine was designed it was specified that the locomotives should not exceed 3 ft. wide and 40 in. in height, as the tunnel is only 6 ft. high at its maximum point. The total weight is about 4½ tons, and a load of 35 tons can be hauled at a speed of five or six miles an hour ; when running light, a speed of ten miles an hour is attained. Two motors are fitted, each having a normal working load of about 12½ h.p., and furnished with means of control from either end. The ordinary hand and emergency brakes are provided, by which the locomotive can be pulled up in almost its own length when running at full speed. The pattern shown has two trolleys, and is intended for use with insulated return conductors. It should be mentioned that this is only one of many types made by the above firm.

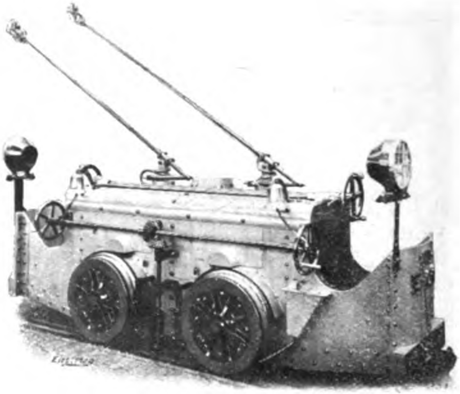


Fig. 2. Electric Construction Co.'s Locomotive.

We also illustrate two locomotives of a recent type constructed by the Société Alsacienne, of Belfort, France. The first is a 5 ton engine, length 9 ft., breadth 3 ft. 6 in., height 6 ft.; the drawbar pull is 800 lbs. under normal conditions, but on emergencies this may be increased to 1,400 lbs. ; mean speed eight miles per hour. The frame beams are of cast-iron, held together by cast-iron ties, to which the couplings are attached. The frame is supported by helical springs, and on the two axles are keyed two wheels 25 in. diameter. The driver's cab contains all the controlling gear, as well as the usual electrical instruments. A four pole series motor, of 800 r.p.m., taking 35 ampères at 500 volts pressure, is used in driving. Current is collected in the usual manner by an overhead trolley (Fig. 3), and returns by the rails. The same engine can be equipped with two motors: its weight would then be 5½ tons, and the drawbar pull 1,800 lbs.

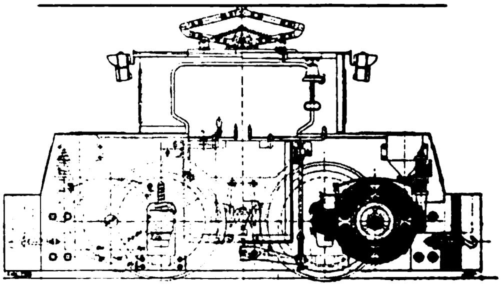


Fig. 4. Societe Alsacienne Locomotive.
Bow Collector.

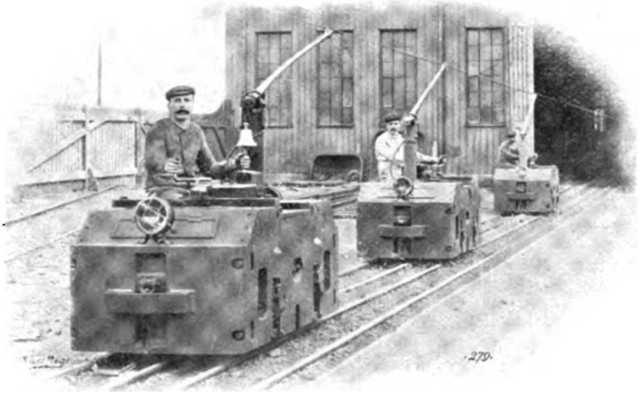


FIG. 3. SOCIETE ALSACIENNE LOCOMOTIVES.
Trolly Collector.

The second engine is a 12 ton locomotive, with a drawbar pull of 3,300 lbs., increasing to 5,500 lbs. if desired; mean speed 17½ miles per hour. The frame and controller of this engine are similar to the first, except that the brake is applied mechanically. The trolley consists of several rollers placed side by side, and fastened to a spring bow, current returning by the rails (Fig 4). These locomotives have been found very suitable, not only for underground work, but also for conveying materials and rubbish in building yards.

A NEW HIGH-SPEED TRIPLE-EXPANSION ENGINE.

An admirable example of recent progress in this country, in the construction of high-speed electrical generating plant for power purposes, is shown in Fig. 1. This engine, made by Messrs. W. H. Allen, Son & Co., Bedford, is of 580 i.h.p., and is direct coupled to a 375 K.W. British Westinghouse dynamo running at 325 revolutions per minute. It was specially designed with a view to obtaining economical results over widely varying conditions of load, when working with dry saturated steam at 150 lbs. per sq. in., and exhausting against a maximum absolute pressure of 4 in. of mercury, and to be further capable of developing an overload of 25% for two hours. The success of the system of balancing the reciprocating parts and the inertia of the valve gear was particularly noticeable during recent trials, and was amply demonstrated by the steadiness of the engine running without holding-down bolts and standing upon a smooth plate. At the official trial, the tests of the governor showed a steady speed variation from no load to full load of 1·9 % and a momentary variation, when the whole load was thrown off or on, of 5%. Appended are a diagram and test figures taken from the official trial, recently carried out at the Queen's Engineering Works, Bedford.

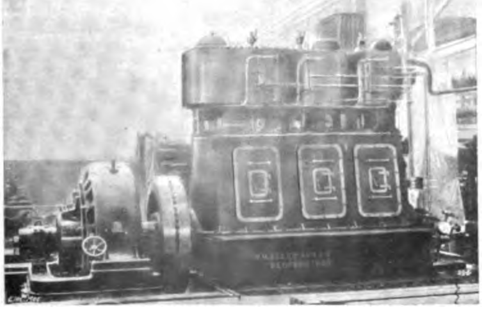


FIG. 1. ALLEN ENGINE AND BRITISH WESTINGHOUSE DYNAMO.

RESULTS OF OFFICIAL TRIAL.

Main Steam Pressure	160 lbs. per sq. in.
Throttled Steam Pressure	143 ,, ,,
Mean I.H.P.	578
Mean B H P.	540
Mean R.P.M.	330
Mean Vacuum at Engine Exhaust ...	25·35 in. mercury.
Total lbs. of water per hour	8190 lbs.
Water per I.H P. per hour...	14·2 ,,
Water per B.H.P. per hour	15·2 ,,
Mechanical Efficiency	93·5 per cent.

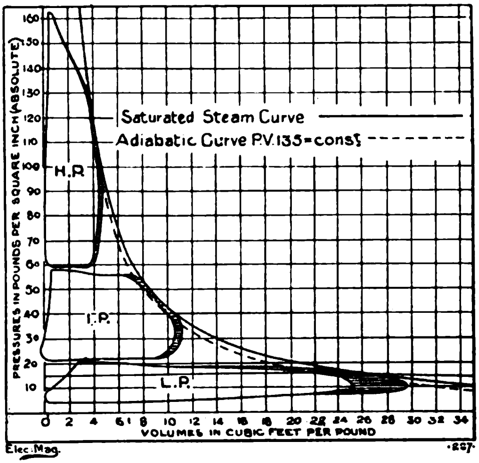


FIG. 2. TEST CURVES OF ALLEN ENGINE.

Adjuster for Incandescent Lamps.

A SIMPLE and novel form of adjuster for incandescent lamps, called the "Electrogrip," has lately been introduced by the Applied Device Company, of Springfield, Mass., and seems to be a most convenient appliance for all sorts of purposes. It consists of a coiled wire grip, made to fit the lamp at one end, and with spring jaws at the other. By a slight pressure the jaws are opened and attachment made to the desired object. For instance, this appliance can be fixed on a machine tool, enabling the workman to throw the light just where he wants it.

EQUILIBRIUM STOP VALVES FOR HIGH-PRESSURE STEAM.

GREEN'S patent valve, manufactured by Messrs. Holden & Brooke, of Manchester, has been designed to overcome the difficulties experienced with other types, such as leakage from unequal expansion, etc., and yet provide a valve which can be opened easily by one man. In Green's system two valves are employed, each actuated independently, but by the same movement. The smaller of the two valves has the pressure on the underside, and the larger valve the pressure on the top, thus causing the smaller valve to open first on putting the operating gear into motion, and to continue open until the pressure is equal on both sides of the larger valve. The extent of lift on the smaller valve is controlled by a stop on the cover. When this stop comes into operation the larger valve (which in the meantime has become balanced) commences to open. Fig. 1 shows the general appearance of this valve; and the independent control levers operated by one hand wheel and screwed spindle. In consequence of this arrangement the valves cannot "float," and it is impossible for them to "chatter," as is the case with most other balanced valves when only slightly opened. Fig. 2 shows Green's valve with the valves in different positions. A shows the small and large valves closed, and B shows the small valve (L) opened and the larger valve (M) closed. When in this position it can be used as a manœuvring valve. C shows the large and small valves full open. The time required for opening or closing is very short, only twelve turns of the hand wheel being necessary for a 10 in. valve from shut to full open, and *vice-versa*. The relative positions of the inlet and outlet can be arranged to suit the lead of the steam pipe. After the valve is fitted in position, the operating gear can be adapted to local circumstances. The valves and seatings are made of the best quality phosphor bronze, and the bodies are of cast-iron, steel, or gun-metal, according to the steam pressure.

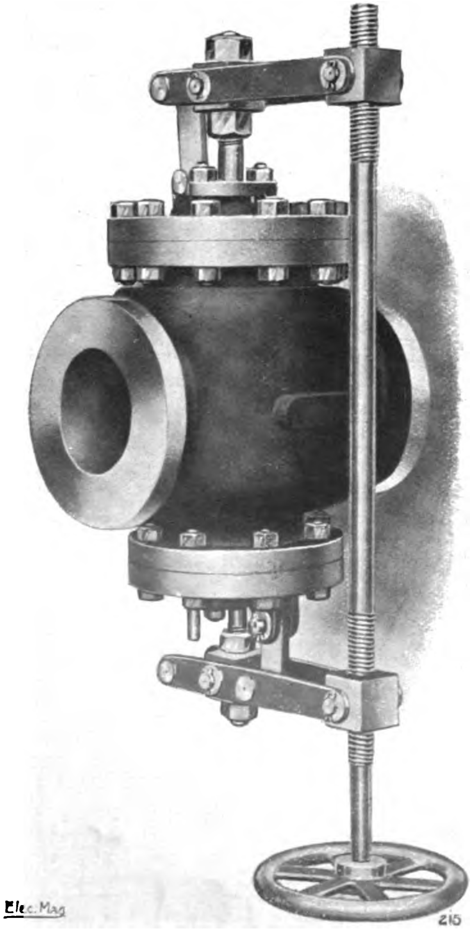


FIG. 1. GREEN'S PATENT VALVE.

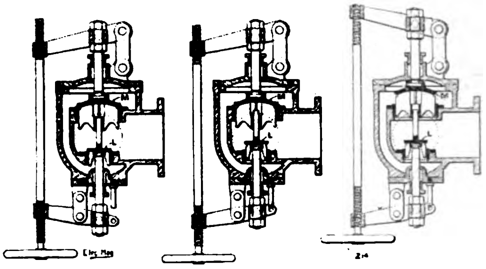


FIG. 2.

BOURNEMOUTH ELECTRICAL EXHIBITION.

THE value of exhibitions in furthering the interests of electricity supply and popularising the uses of electricity cannot be over-estimated, and when such enterprising concerns as the Bournemouth and Poole Electricity Supply Company, Limited, take steps with this object in view, too much attention cannot be drawn to the circumstance. During the time the recent exhibition at Mount Dore was open, March 16th to 23rd, considerable interest was excited, and doubtless the immediate future will bring a reflex of the

STAND AT BOURNEMOUTH EXHIBITION.

Bournemouth Exhibition.

company's efforts and those of its supporters, in the shape of improved trade and business. From a personal inspection of the exhibits we can testify to the care expended in making everything fully attractive, while the utmost courtesy was shown to all enquirers at the various stands. The exhibition was opened by the Mayor of Bournemouth, and after the ceremony lunch was served at the Hotel Mount Dore, and the success of the exhibition duly toasted.

We reproduce herewith views of some of the chief stands which will bear out fully our eulogies on their preparation. The appliances on view ranged from the delicate apparatus used in X ray work to high power motors for use on the mains. The Supply Company's stand contained a Waygood electric lift in operation; while there were also on the same spot, the chief transformers, etc., used for supplying the exhibition. Some 150 h.p. in transformers and 20 h.p. in direct current was installed.

We append herewith the names of the chief exhibitors and their exhibits:—

The Bournemouth and Poole Electricity Supply Company, Limited	Lifts, Motors, Transformers, etc.
G. E. Bridge and Co.	Finsen Lamps, Electro-Medical Apparatus.
Messrs. Bacon and Curtis	Illuminated Decorated Dinner Table Fittings.
W. Haydon	Radiators, Fittings, etc.
Cash's Stores	Bells, Electric Novelties, Tea Kettles, etc.
G. Shears and Sons	"Synchronome" Motors, etc.
E. Bryant	Ventilating Fans.
Messrs. Scott and Scott	Motors, etc.
Messrs. Bayley and Sons	Fittings, etc.
Cecil Cooper and Co.	The Electrophone Lamps, Fittings, Accessories, etc.

Bournemouth Exhibition.

We are indebted to Mr. W. Haydon for the photographs reproduced with this article.

LINOLITE.

Since the general application of electricity to the illumination of shop windows and other interiors where it is desirable the source of light should be hidden, lighting contractors have tried many devices with the object of throwing a brilliant light upon the articles to be exhibited, without dazzling the eyes of observers. This object can readily be attained by the employment of Linolite, a linear arrangement of incandescent carbon films, literally producing a "line o' light," and thereby suggesting the appropriate name of this invention, patented by Mr. A. W. Beuttell, and manufactured by the Linolite Company, of 47 Victoria Street, Westminster. When applied to shop window lighting Linolite provides that the goods displayed are brilliantly illuminated, and yet not even a single direct ray of light passes out into the street. A window fitted with Linolite leaves a clear space for dressing. The fittings are narrow and continuous, and the lamps, contained as they are within a hollow reflector, are free from risk of damage, and the contour of the window is left unimpaired.

As our readers are aware one of the most effective and pleasing methods of illumination in mansions and public buildings is the employment of reflected light. In applying this method, lengths of Linolite are run round the cornices or suspended from picture rails, about 18 in. below the ceiling, the light being directed upwards upon the white ceiling. Linolite was thus used with most successful results for lighting the hall of the India Office on the occasion of the reception of the Indian Princes at the King's coronation. For the illumination of pictures, Linolite is placed below, and the light is directed forwards and upwards. The reflection from any glazing is then thrown upon the ceiling instead of into the eyes of the spectator. It is also very suitable for outlining buildings on public and other occasions. In these cases the reflector faces the spectator and the effect is brilliant in the extreme. Westminster City Hall, Trafalgar Square, was so outlined with Linolite at the Coronation. The construction of of Linolite may be seen from the diagrams here reproduced. The Linolite tubular lamp is exactly the same in principle as an ordinary electric glow lamp. The light is generated by a carbon filament in a glass tube from which the air has been exhausted. Fig. 1 shows part of a length of Linolite in plan and section. There are, however, one or two important points of difference between Linolite and an ordinary glow lamp. In the

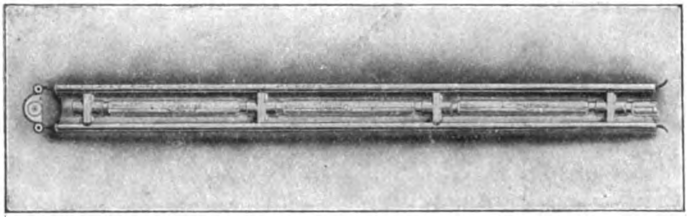


Fig. 1. Linolite. Plan and Section.

Linolite lamps the filaments are the same length as those in ordinary glow lamps, but instead of being coiled up they are either quite straight or have a small expansion loop at the centre. All parts of the filament are thus in the same position as regards the reflector, and the relative positions of these are such as give the greatest possible efficiency. Consequently the light is better distributed, and from two to four times the usual length of reflector is placed behind the same length of filament. This has been shown by careful photometric measurements to vastly increase the amount of light thrown forward throughout a very wide angle. Another advantage of Linolite is that there is one terminal at each end of the lamps and the chance of electrical leakage between the terminals is therefore practically obviated. The plungers in the holders make contact with small centre contacts at each end of the lamps, and it is impossible to touch any of the "live" parts when the lamps are in the holders. The lamps are readily removed and replaced. As will be seen by Fig. 2, the continuous metal reflection is in the form of a semicircular channel with the two edges rolled round to form two small beads. Each of these beads carries one of the wires, which are thus kept apart and well protected from injury. On low pressure circuits the lamps are arranged in parallel, but on circuits of 200 or more volts, they are arranged in pairs, in series. For outdoor work the reflector is made of white enamelled zinc. When used in exposed positions the lamps are held in position by spring clips, mounted on insulating blocks, and the lamps instead of having centre contact caps are fitted with spherical caps. The clips are shaped to these caps, and the lamps have merely to be pressed into position.

Instead of a single line of light, four lines of lamps may be arranged side by side in a single reflector. This pattern is useful for illuminating signboards. The overall width of Linolite is 2¼ in. the depth 1⅜ in., and the weight of the aluminium pattern less than 7 oz. per ft. run, consequently it can be fixed in places where other illuminating devices cannot. When required in a horizontal position, Linolite can be very conveniently supported by small chain slings attached to hooks on a picture rail, to hooks screwed into the ceiling, or to brackets affixed to the walls.

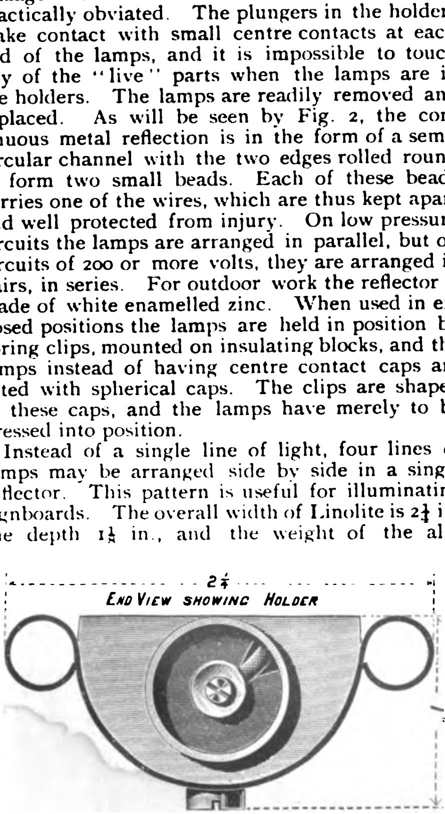


Fig. 2. Linolite. Section through Channel.

Linolite is practically shadowless, and a solid black ruler or other similar body can be placed close in front of it without causing any shadow. In cases where the light may be seen direct, the lamps are slightly frosted, and the effect of this is extremely pretty, for not only do we see the frosted lamp aglow, but also its reflection in the highly polished aluminium reflector, the whole giving the appearance of a long band of soft light about 1½ in. wide.

This ingenious adaptation of the electric incandescent lamp is already beyond the experimental stage, and has been adopted in a large number of business houses, theatres, municipal buildings, and mansions, and we learn that it has recently been applied by Mr. W. H. Massey, consulting electrician to His Majesty the King.

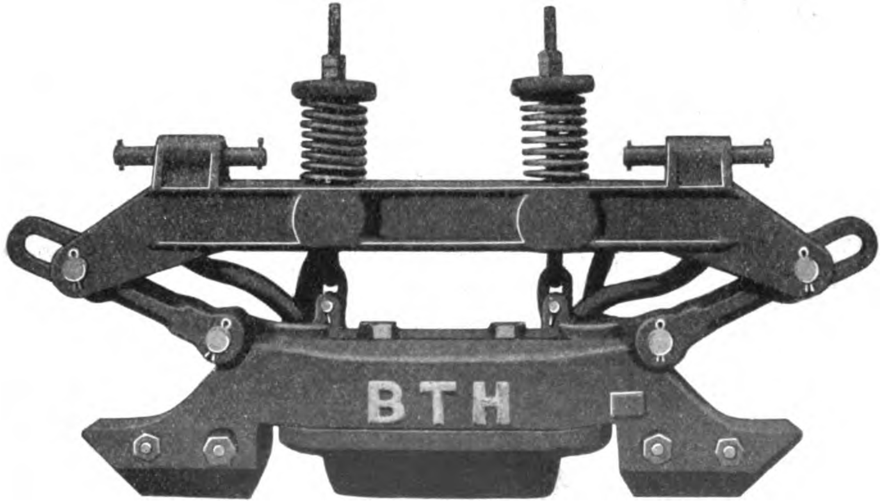
◆

THE B.T.H. ELECTRO-MAGNETIC TRACK BRAKE.

Recent advances in the size and weight of tramcars have emphasised the necessity for reliable brakes, which can be depended upon to control these cars either in cases of emergency or in making service stops. To meet this requirement, the British Thomson-Houston Co. has developed the Electro-Magnetic Track Brake described below. The device consists of suitable electro-magnets mounted in proximity to the track, and which when energised by current are drawn into contact with the rails. Current is generated by the motors acting as generators, and the braking action is obtained both by the drag of the electro-magnets on the rails and by the direct retardation of the wheels, due to the motors acting as generators.

The brake increases the effective adhesion of the car, the adhesive force between brake shoe and rails being about one ton for each brake magnet. Accurate control is thus ensured even on wet and greasy rails. Being entirely independent of the wheel-brakes, it is impossible to skid the wheels by the application of the track brake. In comparison with the "rheostatic" method of braking, it requires less current for the same effective braking effort, with a consequent reduction in the heating of the motors, in the strain on the insulation, and in the wear of the gears and pinions. Being energised by current from the motors, the brake is quite independent of the line current, and it will act whether the car is running forwards or backwards. It is especially well suited for coasting down gradients at a uniform and safe speed, with the car under perfect control at all times. The brake shoes are supported on compression springs, thereby preventing the shoes from dragging on the track in case the springs break. All the apparatus involved is of the simplest character. The brake may be applied to any tramcar, equipped with a rheostatic braking controller, with but slight alterations to the car wiring, and without any changes in or interference with the existing hand brake gear. The brake consists of a cast-steel shoe suspended from a bracket fastened to the side of the car truck. This bracket is well ribbed and braced, and is provided with heavy lugs which take the thrust through cast-steel links in compression. The bracket is formed to act as the seat for two compression springs which support the brake proper by wrought-iron eye bolts. These springs keep the brake shoe free from the track when it is not in use.

The brake shoe consists of a substantial steel casting with a cored recess into which the magnetising coil is placed. A brass cap or cover is placed over this coil to form a water-tight protection. A steel core extends through the coil providing two magnetic circuits, each of which is completed by the section of rail immediately under the brake shoe. The terminals of the magnetising coil consist of well insulated flexible wires brought out through bushed holes in the top of the cast-steel frame of the shoe. They consist of two wires in duplicate, and are of sufficient length to reach the car underframing without a joint.



B. T. H. Electro-Magnetic Tramcar Brake.

Each shoe is provided with wearing plates for contact with the rails. These plates are steel castings, held in place by machined bolts so placed that the plates may be renewed without removing the brake shoe from the truck. The brake has been developed in two different forms.

Form A consists of a large shoe with a bracket designed to suit the various types of single trucks. Two shoes of this type constitute a set, the windings being connected in parallel. This insures protection against failure should the winding of one shoe open-circuit. Form C is designed for Bogie cars, four shoes per car constituting a set, and one shoe being attached to each side frame of each truck. The operating coils of the two shoes on one Bogie truck are placed in series, and these are placed in parallel with the two on the other Bogie truck. Thus in case of injury to any one shoe or coil only half of the braking effort of the car would be rendered inoperative.

RIEDLER-STUMPF STEAM TURBINES.

Profs. Riedler and Stumpf have recently made public, methods of turbine constructions which aim at reducing the number of revolutions consistent with economical steam consumption. They constructed wheels on the de Laval principle, but increased the wheel diameter to 6·5 to 7·7 ft., so that the necessary circumferential velocity could be attained without an enormous and practically impossible number of revolutions per minute. These wheels are constructed as massive nickel-steel discs, the factor of safety being 5, and they are balanced so exactly that the centre of gravity is precisely in the centre of rotation. The bearings are placed quite near the disc, and the blades are milled like pockets in the rim of the wheel. The pockets may be constructed in pairs, and in that case are somewhat like the buckets of a Pelton wheel. The Riedler-Stumpf construction, instead of the eight nozzles employed by Laval, has nozzles of rectangular section close together on the whole circumference of the moving wheel, so that the steam acts in a broad ring. The play between the stationary and moving parts can thereby be as little as $\frac{1}{8}$ in. to $\frac{1}{12}$ in. A 2,000 h.p. turbine of this construction is now working in the Moabit electric supply station of the Allgemeine Elektricitäts-Gesellschaft. The steam pressure is 200 lbs. per sq. in. The turbine wheel weighs only 7·6 tons, and is direct-coupled to the dynamo, the mechanical efficiency amounting to almost 100%. The kinetic energy of the steam can be utilised in several wheels in succession, only a part of the energy being used for the first wheel. This is easily achieved by adopting suitable dimensions for the angles of the vanes at the points of inlet and outlet, guiding the steam to a second moving wheel, where it again loses part of its energy, and then, if required, is passed to a third and fourth wheel. This principle may be carried out in two ways: the steam is either carried from the expansion nozzles over the first moving wheel, and thence by reversing guide blades back to the same vanes, or it may be carried to a second wheel. The second method is preferable and is being employed in the A.E.G. in machines from 20 to 500 K.W. capacity. The smaller sizes are well adapted for small lighting sets, placed on the locomotive boilers for the illumination of railway trains. A third design, somewhat to the Curtis in construction, has, at the same time, pressure and velocity staging. The steam expands in nozzles to a certain degree and then transmits kinetic energy to separate wheels in succession; it then expands to a greater extent in a second system of nozzles, until its pressure has fallen to that of the atmosphere or condenser, and all its velocity is lost. One noteworthy feature of the Riedler-Stumpf turbines is to be found in the application of centrifugal jet condensers to the turbine shaft. This arrangement may be used with either vertical or horizontal construction. In the latter case, when the dynamo is attached to one end of the turbine shaft, the condenser wheel is attached to the other end. The following figures, given by Prof. Riedler in a paper recently read before the Schiffbautechnische Gesellschaft, show the practical results already attained by his turbines:—

Where working.	Capacity.	Steam pressure lbs. per sq. in.	Condenser pressure lbs. per sq. in.	No. of revs.	Temp Centigrade	Steam Consumption per kw. hour
Berlin Electric Supply Works	1,365 kw. 1,920 hp.	130 170	2·1 1·2	3,000 3,800	294° 300°	19·6 lbs. 17·4 lbs.
At ½-load	850 kw.	116	9·2 (vacuum)	3,000	290	20·3 lbs.

THE HELIOS 3,000 K.W. ALTERNATOR.

In the course of a series of articles on this subject in *La Revue Technique*, M. C. V. Guilbert describes a large generating set of 3,000 K.W. capacity made by the Societe Helios and the Ateliers de Grevenbroich. This was the most powerful group of the kind at the Dusseldorf Exhibition, and consisted of the 3,000 K.W. Helios alternator, which was a feature of considerable interest at the Paris Exhibition of 1900, and a tandem cross-coupled triple-expansion horizontal steam engine. The Helios alternator exhibited no important modifications in its new position, the only one worthy of note being the complete rewinding of the armature, but with the same constants as in the former machine. The following are the complete details of the alternator some of which have not been previously published:—

	Three-phase.	Single-phase.
Nominal power, kilowatts	3,000	2,000
Minimum power factor ...	0·7	0·7
Actual power in K.W. for *cos* ϕ minimum ...	2,100	1,400
Nature of currents ...	Three-phse.	Simple Alt.
Tension at terminals, volts	2,200	2,200
Tension per phase, volts...	—	2,200
Intensity of current per phase, amps.	788	910
Angular speed, revs. per min.	71·5	
Frequency in periods per sec.	50	
Field Magnets.		
No. of poles...	84	
Dia. of magnet at extremity of poles centimeters	800	
Speed at periphery, metres per sec.	30	
Form of poles	rectangular, edges rounded.	
Length of poles, centimetres	35	
Width of poles, cm. ...	20	
Cross-section of poles, sq. cm.	700	
Form of section of pole cores	circular	
Dia. of pole cores, cm. ...	21	
Section of pole cores, sq. cm	345	
Exterior dia. of rim, cm.	747	
Interior dia. of rim, cm....	627	
Width of field magnet frame, sq. cm.	80	
Section of field magnet frame, sq. cm.	2,150	
No. coils	84	
No turns per coil	50	
No. circuits in parallel ...	1	
Resistance of the circuit to heat, ohms	0·7	
Weight of copper, kilos ...	3,500	
Weight of copper, kg. per K.W.	1·17	
Weight of field magnets, without shaft, kilos ...	76,000	
Armature.		
Air gap, millimeters ...	13	
Dia. of armature at air gap, cm.	802·4	
Radial height of armature plates, cm.	18·5	
Total width of armature rings, cm....	30	
Exterior dia of armature frame, cm.	940	
Total width of armature frame, cm...	84	
No. of holes per pole ...	8	
No. of coils of principal circuit	84	
No. of coils auxiliary circuits	42	
Grouping of coils of principal circuit	3 sets of 28 coils in parallel.	
Grouping of coils of auxiliary circuits	3 sets of 14 coils in parallel.	
No of turns per coil of principal circuit	9	
No. of turns per coil of auxiliary circuit	12	
No of conductors per hole	3 princ. circuit 6 auxil. circuits	
Weight of copper, in kilos	820	
Weight of copper armature, kilos per K.W. ...	0·274 three-phase currents.	
Weight of armature in kilos	80,000	
Tests.		
Exciting current no load, amps.	120	
Exciting current full load, for cos $\phi = 1$	180	
Losses, field magnet, for cos $\phi = 1$ Joules ...	24,000	

Construction of Dynamos in Germany.

Dynamos with Slotted Armatures.

AMONG other generating plant manufactured by M. M. Schorch & Cie., of Rheydt, the following sets present some interesting constructional details. The first set, of 250 K.W. at 200 revolutions per minute, consists of a 440 volt dynamo direct coupled to a vertical compound steam engine by MM. Meer Bros., of Gladbach. The second set, of 200 K.W. at 140 revolutions per minnte, comprises a 440-volt dynamo with a horizontal compound tandem steam engine, by M. Oskar Recke, of Rheydt. The two dynamos are of similar type, but have a different number of poles. The field magnet frame is of steel, in two parts laid one upon the other, lateral displacement being prevented by means of a dovetailed joint. The armature support is a fly wheel formed of a single casting, on the periphery of which the core plates are bolted between two discs. These carry the rims, held in position by ribs which in turn support the windings on the one side, and the commutator bars on the other. The commutator, therefore, is of a diameter nearly equal to that of the armature, so that the ends of the windings can be fastened directly to the bars. The armature is constructed with rectangular openings only wide enough to permit the passage of the conductors, which are held in position by strips of hard wood. The brush carrier supports are held in collars so arranged that when a screw is loosened, any carrier can be moved tangentially to the collector without any necessity for touching the others. The other generating sets by the same firm are of 100 K.W. and 27 K.W. capacity at 400 revolutions per minute. The former of these sets is actuated by a steam engine by Kirberg and Hüls, of Hulden, and the latter by a Deutz gas engine. The magnets of both these dynamos are of steeel, and consist of two parts, the general construction being similar to that employed some years since by M. Dobrowolsky. MM. Schorch & Cie. consider that leakage between the cores and the poles is sufficiently reduced by the omission of the joint between the parts. The magnetic leakage has also been reduced as far as possible, so that the total loss is within reasonable limits. The armature of these dynamos is similar to that of the machines mentioned above. The generating set described below is made by M. E. H. Geist and MM. Dietrich & Bräcksieck. The steam engine by the latter firm is of horizontal compound coupled type, and the Geist dynamo of 155 K.W. capacity at 400 revolutions per minute. The field magnet frame is of steel, formed in one piece bolted to the bed, and the steel induction poles are attached to the frame by screws. The bed has three bearings and the dynamo is rope-driven. The armature support is in two parts the hubs of which fit into each other. The two parts which form the core are fastened by insulated bolts which pass completely through the plates. The commutator is mounted on a separate support keyed upon the shaft, and the plates, insulated with mica, are secured by a wrought-iron ring held in place by a screw. The support of the shafts of the brush carriers is fastened upon a ring cast with the bearing of the collector.

A New Smoke Consumer.

A NEW form of smoke consumer which promises to be more successful than any hitherto invented, has recently been installed in the Hornsey Electricity Works. The apparatus differs from other smoke consumers as the air injected at the back of the bridge is heated from a source entirely independent of the main furnaces. Gas is generated in a producer, and a mixture of air and steam is forced through the generator grate in the usual way; the producer being water sealed. The gas is then delivered through a main pipe to the three Fraser and Fraser dry back marine boilers; two 3-inch branch pipes carrying the gas to the back of the firebridge in each furnace. Over the outlets of these pipes, a combustion chamber, or regenerator, is built of specially shaped firebricks, laid without any fireclay, and so arranged in a zig-zag fashion that air admitted through the air door has to pass through a series of brick chambers heated by the gas flame from the end of the 3-inch pipes. Round the crown of the furnace and over the regenerator is built a fire brick arch which thoroughly mixes the partially consumed gases coming from the furnace with the hot air supply from the regenerator. As a smoke consumer this apparatus appears to be entirely satisfactory. It is possible to burn cheap bituminous slack with a minimum of smoke. Since it has been used at the Hornsey Electricity Works, much cheaper coal has been burned and the cost per unit has been considerably decreased. Another advantage of the arrangement is found in the steadier steaming of the boilers. The gas flame forms a constant and steady source of heat, the regenerator really acting as an extension of the grate area, with a constant evaporative value, and the stokers find it easier to maintain an even steam pressure. In order to bring a stand-by boiler up to pressure, and to keep it there till required, it is only necessary to spread the old ashes and clinkers over the furnace bars. We learn that Mr. Norman Staniland, the Borough Electrical Engineer, will be pleased to show the apparatus to any station engineer who may be interested in the smoke abatement question.

Motor-Driven Double-Geared Drilling Machine.

A NEW pattern heavy vertical drilling machine, arranged for electric driving, has lately been constructed by Messrs. G. Wilkinson & Sons, of Keighley. The framing of the machine is of box section, rendering it very rigid against strains. A swivel table, measuring 1 ft. 8 in. long by 1 ft. 6½ in. wide and 1 ft. 4½ in. deep, is fitted to the standard, and can be adjusted in height through a distance of 1 ft. 10 in. This table is provided with T slots on its top, and also on its side; and can be traversed along its arm by screw and handle. It can be swung entirely clear of the front of the machine, so as to be out of the way of any work secured to the T slots in the base-plate. The base-plate is forked at the front of the standard, thus enabling long articles to be drilled with the aid of a drill pit below the foundation. The spindle has a traverse of 16 in., and is fitted with variable hand and power feeds. The overhang provided is sufficient to admit of work 3 ft. 6 in. in diameter being drilled at the centre, whilst the maximum height admissible between the table and the spindle is 2 ft. 7 in., and between the spindle and the base-plate 3 ft. 10 in. The motor, of 3 h.p. when running at 1,200 revolutions per minute, is fixed at the top of the drill standard, and its armature spindle carries a raw hide pinion of 16 teeth, geared into a wheel of 36 teeth on the second motion shaft, the pinion on which drives an 8-speed change-gear controlled by the lever at the back of the machine. All the readily-accessible gears are thoroughly cased in, so that no injury can be caused to the workmen.

The Kennington and Fawcett Trolley Base for Tramcars.

A SHORT trolley base, patented by Mr. F. Kennington, of Leeds, and Mr. Fawcett, of Grimsby, will be found especially useful in connection with the covered-in saloons which are now being adopted for the upper decks of tramcars. This base not only answers its intended purpose so far as height is concerned, but is so constructed that, at whatever angle the trolley arm may be, the pressure on the trolley wire is practically the same. The principle upon which the base is constructed consists of a ball race at the top and bottom of the main bearing. All the bearing portions throughout are of hardened steel, thus giving a very easy motion, with little resistance to the wire track. The equal pressure of the trolley arm on the wire is attained by placing the fulcrum point higher and farther away from the springs than in the ordinary standard, thus reducing the fulcrum as the pole is brought down to the horizontal line. There are three springs arranged side by side, which can be adjusted to suit any tension. All the bearings run in an oil bath, and are so arranged as to prevent the admission of water. A Stauffer lubricator is fixed at the back, which has connections to all joints requiring lubrication. Access to the cable is obtained by the removal of two screws from the top plate. All portions of the base are made of hard steel. Messrs. Harper, Phillips & Co., Ltd., of Grimsby, are the sole manufacturers of this device, which we understand is being adopted in the Leeds and Hull Corporation tramway systems.

Low Voltage Generators.

A NUMBER of low voltage generators, in which the densities at the pole shanks range from 20,000 gausses to 23,000 gausses in the larger machines, have recently been placed on the market by Mr. C. J. Bogue, of New York. The section of the steel at the pole-shanks is so reduced that from 50 to 60 per cent. of the field ampère turns are expended in the poles. All the other parts of the magnetic circuit are so proportioned as to reduce the reluctance to a minimum. The pole-shoes have an area from three to four times the sectional area of the pole shank, and owing to the narrow armature slots a thin gap may be used, thus giving a very low gap density. In order to take the fullest advantage of this low density, the pole-tips are shaped so that they shall be over-saturated at their junction with the pole proper. This gives an unusually even density in the gap under all loads, and enables the machines to run from zero load to a heavy overload without any perceptible shifting of the neutral, and consequently without sparking. For the purpose of keeping down the heating, and using as little magnetising force as possible, so that it may concentrate in the poles, the armatures are run at the low density of about 6,000 gausses, and the yokes are proportioned so as to have a low saturation, about 3 or 4 per cent. of the field ampère-turns being taken. The result of the combination of these various features is a shunt machine which the maker claims will regulate on practical work better than a perfectly compounded machine, or than an ordinary low-density shunt machine. In cases where a perfectly even voltage must be kept, the maker advises separate excitation, the fields being wound for 110 or 220 volts.

Electrically Driven Milling Machines.

A NEW design of motor-driven milling machine, which the Cincinnati Milling Machine Company have recently brought out, is the result of a long study of the problem of electric driving as applied to milling machines. The design is based upon the use of a variable speed motor, and in this particular case the builders employ a shunt-wound direct-current motor operated by a field rheostat. As speed vibration is obtained from the motor, the usual mass of gearing is unnecessary, and when the rheostat has once been set to give the desired speed for a particular job, it need not be disturbed when starting the machine or motor. The motor is bolted to an extension, cast upon the base of the machine. This brings it near the floor, thereby increasing the stability, and, the entire arrangement being at the rear, merely occupies space which would not be available for other purposes. These milling machines are entirely suitable for shops employing the multiple voltage system, in which case they will use only one of the several voltages, thereby simplifying the wiring and controlling apparatus. A friction clutch transmitting power from the motor gives the operator complete and convenient control, and is also handy for making a partial revolution of the spindle.

A Combination Plug and Socket.

A NOVEL form of plug and socket, designed by Mr. W. H. Kelsey, of Cleveland, Ohio, possesses several features of merit. When the device is used as an attaching plug, the opposite ends may contain either an Edison or a Thomson-Houston plug. Contacts with the electrical connections of either are made from the same supporting arms within the holder. Either the Edison or the Thomson-Houston plug may be attached to its proper socket by reversing either end of this double plug. Another feature of this device is that the cord is not twisted. In avoiding twisting, the double plug is removed from the holding arms, and the detached part is screwed into the corresponding socket. The holder, with its connecting arms, which carries the connecting cord, is then slipped into proper place, the arms snapping tightly to the side contacts of the plug. If used as an electric lamp socket, the reversible portion of the device may contain two sockets—one in each end. In this way two lamps can be held, either in multiple or in series, by making the proper connections. The plug may also be used as an extension socket, so that any two pieces of apparatus may be run from the same connecting plug.

No. 5 of "The Electrical Magazine" should be ordered at once, as its contents will be of exceptional value to manufacturers.

Central Station Practice

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

* * *

Refuse Destructors and Electricity Works.

By F. L. WATSON, Assoc.M.Inst.C.E.

THERE has been a great deal of controversy on this subject, and most of it arises from misconceptions. The destructor is a recognised necessity in every town: the same may now be said of the electric lighting works.

The destructor is capable, without any serious addition to its working expenses, of producing steam power, which is roughly equivalent to five horse-power per thousand of the population: it is clearly advisable that this power should be used, and it frequently happens that the electric light and power station affords the best way of using it. But it should be recognised that the destructor does not exist for the benefit of the electricity works, and the latter must not be charged with the whole cost of running the destructor. This cost should be shared between the cleansing and electricity departments, and the electricity department should not pay more than the cost of generating the same amount of steam by coal. The cost of labour on any good destructor will not exceed the cost of generating the same quantity of steam by coal, and will frequently be less; so that the electricity department is making a good bargain (unless there be something wrong with the destructor) if it pays for the labour on the plant. Those glowing reports of enormous steaming results (generally far in excess of the chemical possibilities of the refuse) which heralded each epoch-making invention in the shape of a new kind of combustion chamber, or a "fancy" grate bar, are now happily out of date, and engineers will nowadays look for low working costs, regular results, and freedom from breakdowns, and will obtain what they want from makers of repute and experience, taking little notice of tests carried out under quite abnormal conditions. The sanitary department must have a voice in the selection of the plant, and should insist on one absolutely free from nuisances; these have, within the memory of most, caused injunctions to be obtained against the continued use of even comparatively modern plants. In these days, when all makers aim at high temperatures and complete combustion, the most frequent source of complaint is dust from the chimney top, which spreads itself over the neighbourhood. Care must be taken that this cannot occur in the plant to be selected.

When the electricity plant comes to its full growth, coal-fired boilers will be needed in addition, and these should always be kept quite separate from the destructor boilers.

In the destructor absolute simplicity should prevail, so that the stokers, who are skilled in handling fires, should not also be asked to show the skill of the mechanic. In the coal-fired boilers every labour-saving appliance may be adopted. Separate water meters should enable an exact record to be kept of the work done by the destructor and coal-fired boilers respectively. The temperature maintained in the destructor combustion chamber should be watched, so that irregularities of stoking may be detected, and the strictest discipline should be maintained in this department, printed time tables and a clock being provided. There is no advantage in dividing up a destructor into a number of units with separate boilers. That is simply throwing away the advantages in labour-saving offered by a large plant, and placing it on a level with small plants. Boilers can now be obtained of very large size, and the units should be made as large as possible, the limit really being the maximum permissible size of the boiler to which the destructor unit is to be connected.

In a well designed and well built plant, duplicate destructors are quite unnecessary, and give rise to a suspicion that frequent repairs are anticipated; a unit consisting of several cells built in one battery permits all ordinary repairs to be done without interfering to any serious extent with the working. All destructors, except quite small ones, should be worked 24 hours a day, the temperature of the brickwork being maintained as nearly constant as possible throughout. In plants having only a small day load, the rate of combustion can be reduced during light load by working with a reduced staff of men, without any loss of economy.

The systems of charging destructors are many and various, but it will be admitted that, as hand-charging by the shovel is more laborious than dumping the refuse in from the top of the furnace, while involving in most cases a lower capital expenditure, the former is more suitable for small, and the latter for large plants. Hand-charging by the shovel may be done either from the front or back of the cell. Forced draught is, of course, a necessity, and is recognised as such by all makers, who are, however, divided into two schools—the advocates, respectively, of steam jet blowers and of fans. The writer is himself a member of the former school, and his opinion is based on experience of both methods.

The removal and disposal of clinker must be provided for, and it will be found that by suitable machinery this material becomes a source of revenue instead of an encumbrance.

If the above points are borne in mind, and the destructor is relied on for what it certainly can do, and not asked to perform what it cannot do, no one can reasonably doubt the advantages of using the destructor as an adjunct to an electric light and power station.

HINTS ON CIRCUIT BREAKERS.

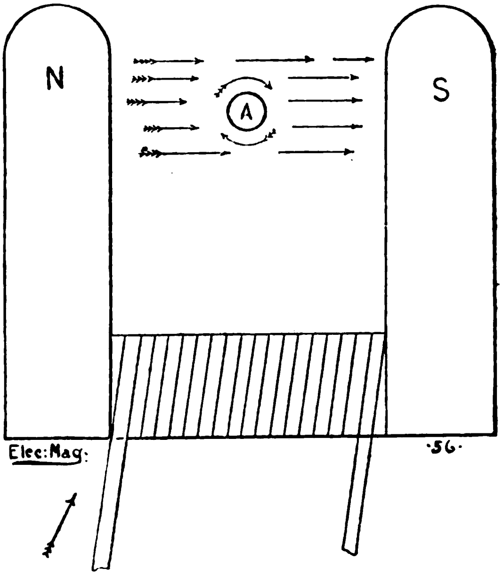


FIG. 1.

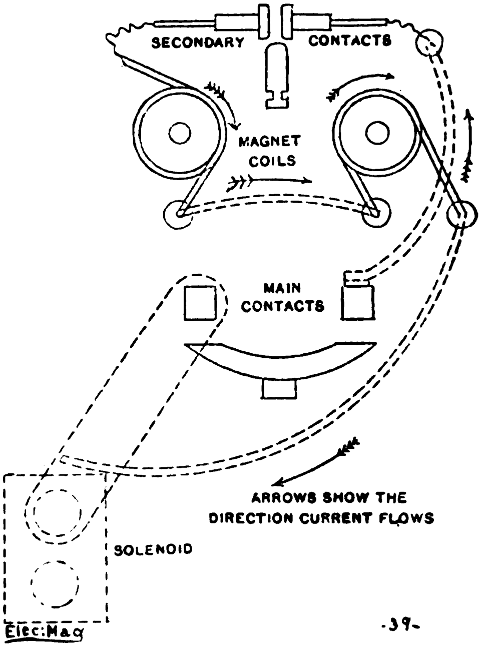


FIG. 2.

IN our February issue we gave some particulars from *Power*, on the "Care of Switchboards," and we are now able to go further into detail on circuit breakers. In Fig. 1 A is the arc, and current is flowing towards you: lines of force are circling round it in a clockwise direction: the lines of force on the upper side of the arc are directed by the lines running in the same direction from N. to S., while those lines on the under side of the arc are repelled, causing the latter to move upwards until it finally breaks. Fig. 2 shows the connections. The efficiency of the magnetic "blow-out" is considerably impaired if proper care is not taken of it. The various parts must be carefully adjusted, contacts smoothed, working parts oiled, and the breaker kept generally clean. All connections on the back of the board require looking over occasionally, as they are apt to work loose and heat up. A set of wrenches to fit the different nuts should be provided for this purpose. Setting up with a cold chisel or a punch and hammer as is done very frequently, is liable to destroy both nut and stud. When tightening up connections with a wrench, remember that the nuts and studs are very soft and undue force will strip the threads. For station lighting a switch is fitted on each generator panel, coupling the back of the main

AVERAGE AMPERES AT DIFFERENT VOLTAGES TO GIVE NORMAL AND VARIOUS OVERLOADS FOR 1,000 K. W. GENERATORS.

Load or Overload.	Kilowatts	Amperes at						
		540 Volts.	550 Volts.	560 Volts.	570 Volts.	580 Volts.	590 Volts.	600 Volts.
Normal	1,000	1,851	1,818	1,785	1,756	1,741	1,694	1,666
10 per cent. over	1,100	2,037	2,000	1,982	1,929	1,896	1,864	1,833
15 ,, ,,	1,150	2,129	2,090	2,053	2,017	1,982	1,949	1,916
20 ,, ,,	1,200	2,222	2,181	2,142	2,105	2,068	2,033	2,000
25 ,, ,,	1,250	2,314	2,272	2,232	2,193	2,158	2,118	2,083
30 ,, ,,	1,300	2,407	2,363	2,321	2,280	2,241	2,203	2,166

switch and circuit breaker, so that all station lights are fed from any generator in case of a station "blow-out." Only one of these switches is used at a time. Before shuting down a machine supplying the station lights, these latter should be changed over to another generator. This can be done without putting out the lights. Be sure to open the lighting switch on the machine that is shutting down, or serious trouble will arise if it is left in until its voltage falls below the line voltage. The table above gives the average load in ampères, at different voltages, to be carried for nominal or any percentage overload.

STEAM FROM REFUSE AND ITS COST.

With a view to obtaining reliable figures on the actual value of the Destructor as a Steam Producer, we recently addressed to the officials of forty-two towns which have adopted Destructors in connection with their electrical departments, a list of questions with a request for their replies.

These questions were as follows :—

(1) Name of Town. (2) Tons of Refuse per day. (3) Steam per lb. of refuse from and at 212° F. (4) Cost of Destructor repairs per annum. (5) Capital charges per annum (Destructor only). (6) Purposes for which steam from Destructor is utilised.

Labour sub-divided as follows : Stokers.

(7) No. employed per shift. (8) Shifts worked per day. (9) Wages per shift. (10, 11, 12, 13, 14 & 15) Chargers and Clinker Wheelers, do. do.

We were courteously favoured with replies to most of these questions from a number of gentlemen, whose names are given in the subjoined table. From these replies we have calculated the cost of labour per ton of refuse and per ton of steam, and we think they may be taken as typical of recent practice.

The cost of coal for evaporating a ton of steam might vary from a minimum of 10d. in colliery districts to a maximum of 2s. in London. The cost of labour would be about 1d. per ton of steam in most cases, so that the total cost may be taken at from 11d. to 25d. per ton for fuel and stokers ; therefore, Destructor steam costing, for fuel and

	Name of Town.	Tons Refuse per Day.	Steam per 1lb. of Refuse from and at 212° F.	Wages per Day. Calculated from data supplied.	Wages per ton Refuse. Calculated from preceding columns.	Wages per ton Steam. Calculated from preceding columns.	Annual Cost of Repairs.	Figures based on data supplied by
1	Beckenham	25	1·51	26/-	12·4d.	8·2d.	£59	A. J. Hedgcock, Esq., Resident Engineer.
2	Canterbury	10	Not given	23/3	27·9d.	—	—	C. A. Blascheck, Esq., City Electrical Engineer.
3	Darwen	30 to 35	1·6	39/2	14·4d.	9d.	£109 14s. 1d.	Charles Garnett, Esq., Boro' Electrical Engineer.
4	Fulham	120	1·2	90/-	9·0d.	7·5d.	£254	Arthur J. Fuller, Esq., Boro' Electrical Engnr.
5	Gloucester	25	1·25 to 1·5	23/-	11·0d.	8d.	—	W. J. Bache, Esq., City Electrical Engineer.
6	Llandudno	14	0·62	20/-	17·1d.	27.5d.	£68	H. Morton, Esq., Electrical Engineer to Council.
7	Nelson	30	1·85	36/-	14·4d.	7.79d.	£58	W. A. Fraser, Esq., Boro' Electrical Engineer.
8	Oldham	64	1·33 (newer cells)	60/-	11·2d.	8·4d.	—	S. W. Newington, Esq., Boro' Electrical Engnr. (Steam from Lord Kelvin's test).
9	St. Helens	51	34 to 37 units of electricity per ton	46/6	10·9d.	—	£350	E. M. Hollingsworth, Esq., Boro' Electrical Engnr.
10	Shipley	25	1·5	27/-	12·9d.	8·6d.	—	S. D. Schofield, Esq., Electrical Engineer.
11	West Hartlepool	60	1·52	45/-	9d.	6d.	—	J. W. Brown, Esq., M Inst. C E., late Boro' Engnr.
12	Wimbledon	54 { 36 Refuse 18 Sludge	1·0	84/-	14·2d.	14·2d.	£200	H. Tomlinson Lee, Esq., Electrical Engineer.
13	Wrexham	35	Not given	21/-	7·2d.	—	£12	Wm. Sillery, Esq., Boro' Electrical Engineer.

stokers, 6d. per ton at West Hartlepool, means a clear saving of 5d. for each ton of steam so produced ; and at Fulham, where the cost of 7·5d. per ton for Destructor steam must be compared with London coal prices, the saving is even greater.

It is worthy of note, that the lowest costs of steam shown in our tables are obtained from the "Horsfall" Destructors at West Hartlepool and Fulham, the "Meldrum" at Nelson, the "Heenan & Froude" at Gloucester, the "Horsfall" at Oldham and Beckenham, and the "Meldrum" at Shipley and Darwen, and it is well known that these are plants which are satisfactory from the sanitary point of view. The first named plants being large have an economic advantage, and the Wimbledon plant is handicapped by burning sludge. The higher costs are obtained on very small plants, and may be neglected. It will be observed that, by asking for the detailed costs of labour instead of asking simply for a figure per ton, we have eliminated the difficulty commonly met with, that different engineers do not include the same work ; for example, some of the results occasionally published apply to stokers only, and do not include the trimming of refuse on the charging decks, or the wheeling out of the clinker. These operations are sometimes the duty of the stokers, and sometimes of separate labourers. In our figures all such jobs are included.

It is also worthy of note that most of the plants referred to have been working several years. We regret we have not been able to give all the costs of repairs, but those we have are very reasonable, and should not prejudice anyone against the combination.

On the whole then, we may say that

(1) The Destructor as a sanitary necessity must be provided by the Cleansing Department, who ought to pay capital charges and repairs.

(2) Being so provided, a saving averaging at least 1s. per ton of refuse may be effected by utilising the steam.

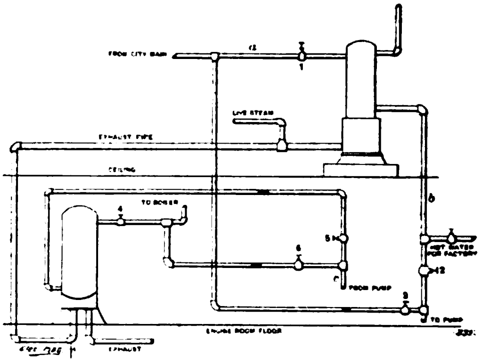
(3) By complete utilisation of steam and of clinker, which can be turned at small expense into a saleable commodity, a good modern Destructor may, and ought to, be made self-supporting.

The last is the object which Destructor makers and managers should place before themselves, and we hope by their energy and intelligence ere long to be able to lay before our readers authentic proofs of its successful attainment.

FEED WATER HEATER ARRANGEMENT.

The attached extract from *Power* will doubtless be of interest, H. J. writes :—

"I herewith present my method of heating the feed water to near boiling point before it enters the boilers, together with a sketch of the piping. The cold water enters the top heater first through the pipe *a* from the city main. I pump the hot water from the heater through the pipe *b*, to the lower heater, through the pipe *c*, and then to the boilers. If the top heater gets out of order, I close the valves 1 and 2, open valve 3, and pump cold water direct from the city main to the lower heater. When the lower heater gets out of order or I want to clean it out, I close the valves 4 and 5, open valve 6 and pump from the top heater direct into the boilers. I never have to pump cold water into the boilers. I also have the top heater arranged to heat the water with live steam when the engine is not running. The upper heater used to lie out in the yard ; I had it put above the engine-room and have made good use of it, although it is a little smaller than the lower heater. We use much hot water in the factory during the cold months, and I used to heat this with live steam, but now I take all this hot water from the top heater. This saves about two tons of coal per week ; besides I get the feed water much hotter than before with one heater, and this saves some more coal."



Feed Water Heater.

Cleaning Boiler Surfaces.

In considering the methods of removing scale from boiler surfaces, Mr. R. T. Shohn, in *The American Electrician*, scouts the opinion of some writers that $\frac{1}{16}$th in. scale increases the fuel consumption by 15%. He, however, goes on to say that unclean surfaces lower the boiler efficiency considerably. In an interesting article a number of devices are described for removing scale chiefly from water tubes, encrusted internally, and also for cleaning them externally. After air is once admitted to a boiler the cleaning should be conducted as rapidly as possible, as the scale quickly solidifies on contact with the air. It is often convenient to enter the boiler at the top (a Lancashire type) and scrape the scale away while lowering the water gradually as the work proceeds. A device patented in England some years ago employed a small refrigerating system, producing a very low temperature inside the boiler. The scale then became brittle and would chip or flake off owing to the different coefficients of expansion of iron and scale. The apparatus comprised a small ammonia compressor and a number of expansion coils placed inside the boiler. The expansion, on removal of the coils, as the boiler resumes its normal temperature assisted in removal of scale particles. The process could not, however, be recommended, except in refrigerating plants. Describing numerous devices for cleaning purposes, the author referred to the hammer type of cleaner as suitable for removing scale from fire tubes. The blows were delivered by a small steam hammer working *inside* the tube and thereby shaking the scale from its outer surface. With water tubes a rotary cutter was to be recommended and in this case a small water turbine rendered dual service in operating the cutters and in washing out the broken scale. Different styles of cutter wheels are furnished with each cleaner, to meet all kinds of scale formations.

ELECTRICAL · WORK and · PRACTICE in · the · Shops

The Artisan's Section.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike; which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

The "Premium" System.

By S. A. CURZON.

ALL engaged in our workshops will watch the result of the experimental adoption of the "Premium System" by the Admiralty authorities very closely. There are many to whom this system is yet a closed book and some explanation as its methods and effects will not be out of place. Firstly, it is a generally accepted theory with first-class men that the payment by the Union flat rate—although of some benefit—leaves much to be desired as a means of calculating wages. The Union, in fixing a minimum, doubtless prevented the undercutting of wages, but the rate has been generally adopted as a maximum. The injustice falls upon the good workman who sees his next door neighbour getting the same rate of pay without producing so much work. Unfortunately the usual result is that the man who could give a much larger output refuses to do so.

By adopting the "Premium System" we get all the good points of the flat rate combined with the extra earning ability of piecework without the latter's inducement to scamp. The "Premium System" entails every job being priced by time. A piece of work is given out to the workman, timed, we will say, at forty hours. If he takes but thirty hours to complete same he will have saved ten hours on the job. He will not receive the ten hours pay. That is a mistake that the majority of those to whom the system is mentioned fall into. His saving is one quarter of the time allowed. He will receive as premium, in addition to his ordinary wages for the thirity hours worked, one quarter of the actual time he has taken on the job—in this case seven-and-a-half hours. Taken at 9d. per hour, the workman will receive 5s. 7½d. extra. The remaining two-and-a-half hours goes to the employer, but as he has to stand to all time taken above that allowed no one will grudge him this. At the same time the man who earns most in premiums becomes the most valuable to his master.

Any individual who takes longer than the time allowed will receive his full week's wages and probably the "sack." The "Premium System" therefore will be a means of eliminating the incompetent hand from our workshops and giving every man inducement to work well and quickly. It is impossible for any man to double his wages by scamping through his work, and with a proper foreman in the shop scamping cannot take place at all.

The question of working overtime is easily adjusted. A man would receive his overtime at extra rate with his ordinary wages but such would only be reckoned as "single" time when making up the amount of premium earned.

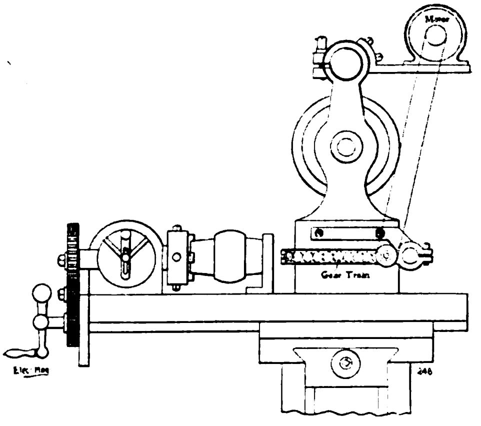
Thus: A piece of work is given out at 30 hours. The man does this in 25 hours, four hours of which were overtime at time and a quarter. He will have five hours to add to his weekly time, but his premium will be for five hours—a saving of one-sixth, the amount credited to him being one-sixth of 25 hours, not of 26 hours. If on examination any man's work is found not up to the mark the premium will be disallowed. Times are reckoned from the start of one job to the start of the next.

Another point is that a man losing time —unless he has permission—will have same reckoned in with the time he has worked, unless such loss is occasioned by a breakdown or some cause beyond the individual's control. The gradual adoption of the "Premium System" is a *desideratum* that mechanics should work for.

INTERNAL MILLING ATTACHMENT.*

The fixture shown in the drawing is used for cutting helical oil channels in large generator bearings, both right and left-hand channels being required in each bearing. The attachment was made of a length sufficient to reach through our longest bearing, and a train of gears of 1 inch pitch diameter and 20 pitch, connected the cutter spindle to the driver spindle, which had a pulley for a belt of sufficient width to drive it properly. As oil channels were being cut in brass with a round-end cutter and the speed must be high, a motor was used to drive the fixture and excellent and rapid results were obtained.

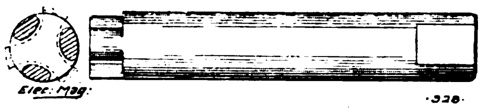
The sketch, taken from the *American Machinist*, will show the method of attaching and operating the arrangement. If this device were to be used for gear or ratchet cutting one would not need the high speed and could drive direct from the main spindle.



INTERNAL MILLING ATTACHMENT.

GETTING OUT A BROKEN TAP.*

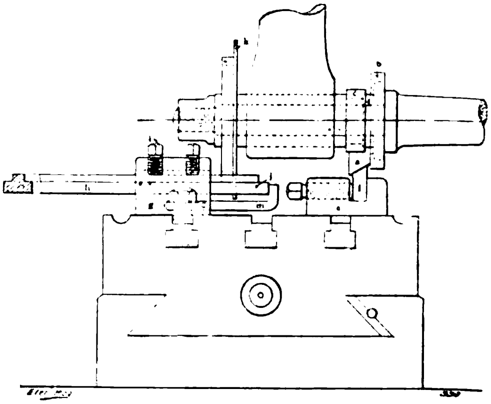
A friend of mine had a tap break the other day, a piece of it being left in the work. When I arrived upon the scene, he was trying to get it out with the aid of hammer and chisel. His usual procedure in such cases (which I believe is the method generally adopted) was to heat up the work, if not too large, till the broken tap was soft enough to allow a hole to be drilled in it and then knock in a square punch, by which means the broken piece can sometimes be removed. In the present case it was impossible to use this method, as there were aluminium parts attached which would be spoiled if made hot. With the aid of a blowpipe, broken taps can sometimes be softened without damaging any of the surrounding parts, as the flame can be directed upon the tap alone. Seeing the trouble in this case reminded me of the little tool shown in the accompanying sketch which I first made the acquaintance of many years ago. During my apprenticeship I had broken a tap in a valuable piece of work which was very urgently wanted. I tried all the ways I could think of to get it out, but all to no purpose. I was afraid to show the foreman what I had done, so I asked the advice of an old hand who had previously put me up to many little kinks. He quickly made a tool like the one shown, and soon had the broken piece out. As will be seen, the three projecting parts go into the corresponding grooves of the tap. The diameter of the tool should of course be a little less than that of the bottom of the thread. C. R.



REMOVING BROKEN TAP.

TWO DIFFERENT JOBS ON THE SAME MILLING MACHINE. *

I had to mill a good many gibs like that shown at *a* in the sketch, using the gang of mills *b*, *c* and *d*. These gibs were cast iron, ¾ inch thick, ranged in length from 10 to 15 inches, and were held in the jig *e* by means of two lugs *f* cast on the bottom. This job consumed no small amount of time. A day came when I had about 75 of these gibs to do, besides about one thousand and one other jobs, and all in a hurry, too. While setting up the machine for the gibs, the fact struck me that I had room on the cutter arbor for another set of cutters and, also, room on the table for another job. So I started a cut across the first gib, looked for another job to put on the machine and selected the one shown to the left in the sketch. The fixture *g* is about 12 inches long, and the pieces *h*, which are planed to the shape shown and in lengths of about 4 feet, are placed in the jig—a number at a time—and held down by means of set-screws *i*. These pieces have to be cut off and milled at *j* by means of the saw *k* and mill *l*, the gage *m* being used to keep all the pieces to the same length.



TWO JOBS ON ONE MILLING MACHINE.

---

* *American Machinist.*

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrcial trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

The Rating of Machinery.

By the ASSOCIATE EDITOR.

THERE is reason for satisfaction at the result of the debate last month in the House of Commons on the second reading of the Bill intended to amend the law of rating as applied to machinery. The substantial majority then secured by the Bill may be taken as a favourable augury of ultimate success, especially when it is remembered that no official support was given by the Government. The measure, introduced by Mr. Edward Chapman, is supported by Sir Edward Strachey, Sir W. H. Houldsworth, Sir John Dorington, Mr. F. Cawley, Sir W. E. M. Tomlinson, Mr. Alfred Emmott and Colonel Royds, and contains the following provisions:—

"From and after January 1st, 1905, in estimating for the purpose of any valuation list, or poor or other local rate, the gross estimated rental and rateable value of any hereditament occupied for any trade, business, or manufacturing purposes, any increased value arising from machines, tools or appliances which are not fixed or are only so fixed that they can be removed from their place without necessitating the removal of any part of the said hereditament shall be excluded.

"Provided that the gross estimated rental of any such hereditament shall be estimated at not less than the sum at which it might reasonably be expected to let for the purpose for which it is used on a tenancy from year to year, void of the machines, tools, and appliances which it might reasonably be expected would be supplied by the tenant, if the tenant paid all the usual tenants' rates and taxes, and if the landlord undertook to bear the cost of the repairs and insurance and the other expenses (if any) necessary to maintain the said hereditament in a state to command such rent.

"Provided also that the terms machines, tools, and appliances for the purposes of this Act shall not apply to any machinery, machine, or plant used in or on the hereditament for producing or transmitting first motive power, or for heating or lighting the said hereditament.

"This Act is not to apply to Scotland or or Ireland."

Nothing could be more reasonable, or more in accordance with the dictates of common sense, than the principles contained in the above extract, and it is surprising to find that any fair-minded men can be found ready to oppose the Bill. Probably much of the opposition encountered is due to misconceptions which apparently exist in certain localities as to the effect of the operation of the proposed amendment of the existing law. We learn that an influential committee is now in course of formation for the purpose of satisfying members of Parliament representing such localities that their apprehensions are absolutely without foundation. This committee will include the following members, with power to add to their number:—Sir W. H. Holland, Sir W. H. Houldsworth, Sir W. E. M. Tomlinson, Sir Edward Strachey, Sir John Rolleston, Mr. A. Emmott, Mr. D. J. Shackleton, Mr. J. White and Mr. Edward Chapman, and it is proposed that the Machinery Users' Association should act in co-operation with the committee.

The principle of rating as defined by the Parochial Assessment Act of 1836 is very simple, and provides that the rates shall be made on the net annual value of the premises occupied. It is perfectly clear that the intention of this Act was that the annual value should be fixed by considering the amount of the rent that might reasonably be expected from year to year from any tenant who might offer himself. But it occurred to the grasping minds of some local Assessment Committees that industrial firms who had established themselves in premises, and laid down the necessary tools and machinery for the prosecution of business, had thereby made the premises of greater value, and should be punished by proportionate increase of taxation. Although the tools so taken into account were in no way fixtures, and although their removal would leave the rental value of the premises the same as before, it was finally decided by the late Lord Esher in the Court of Appeal that machinery should be taken into consideration for the purpose of enhancing the rental value of premises. This decision is extremely illogical, and its absurdity is further increased by the *dictum* of the late Lord Justice Lopes, a member of the same Court, that machinery is not *per se* rateable.

The decision to which we refer has had the effect of grafting upon the original law of assessment a meaning which was never intended, and which has been extensively used by local authorities as a means of inflicting much hardship upon manufacturers of all classes.

At the present time it is particularly desirable that the law should declare the rateable value of any factory to be its actual value, apart from the owner's or tenant's tools, but fixed and immovable machinery should be taken as forming part of the premises for the purposes of taxation. It is quite as unjust to saddle manufacturers with rates levied on their tools as it would be on their stock in trade. The release of machinery from rates means a reduction in the cost of manufacture and an increased ability to cope with foreign competition.

◆ ◆

NOTES ON HOME TRADE.

Imports of Foreign Electrical Machinery and Apparatus.

THE returns for foreign electrical machinery imported into this country during January, 1904, are £46,937, as compared with £49,375 in December, 1903, and £62,137 in January, 1903. The value of the imports of foreign electrical goods and apparatus (other than machinery) for January last was £74,674, as compared with £52,777 in January, 1903.

Ventilation of the House of Commons.

IN spite of the many attempts made to improve the ventilation of the Houses of Parliament, it is undoubtedly a fact that members have experienced very depressing effects therein, and it has now been decided to thoroughly overhaul the arrangements, and to install new ventilating plant. Messrs. Matthews and Yates, Ltd., of Swinton, Manchester, also of London, Leeds, Glasgow, etc., have been entrusted with the order for this plant, and it is hoped by the commencement of another session to have it installed. Experiments already made give the assurance that such an improvement will be effected throughout, that members will have no further cause for complaint. During the past two years or so, Messrs. Matthews and Yates have supplied some 60 or 70 fans for the ventilation of committee rooms, division lobbies, lavatories, etc., and it is doubtless due to the satisfactory working of these fans, and the results obtained therefrom, that they have now been entrusted with the larger work of ventilating the debating chamber itself.

London Underground Railways. The Wiles of the American Capitalist.

IT has been estimated that fully one half of the work involved in the electrification of the London Underground Railways will be done in the United States, which will mean a loss of about £1,000,000 to British manufacturers. The sum which has left this country may be even greater than £1,000,000, for that limit is based on the assumption that the Westinghouse Company will execute all the work included in their £600,000 contract in England. If compelled, as on previous occasions, to buy some of the plant in the United States, further loss will fall upon British workers. Commenting upon this filching of British trade, the head of one of the largest electrical firms in the country says that "if there had been a duty of only 10 per cent. the whole of the Yerkes contract would have remained in this country. German and American firms would not be able to hide themselves behind British registration if we protected ourselves. Either they would have to manufacture the goods over here or they would have to retire from the field. At present we have foreign firms, nominally British, capturing British contracts and bringing their goods into our country." The only satisfactory feature in this affair is that the sixty-four Babcock boilers required will all be made at the Renfrew works of the Babcock & Wilcox Company.

◆ ◆

FOREIGN NOTES.

Imports of Electrical Apparatus to Alexandria.

ACCORDING to a recent Foreign Office report, the total imports of telegraphic, telephonic, and other electrical apparatus into Alexandria for the year 1902 amounted to £52,019, or 30 per cent. more than the four years' average. The United Kingdom rose from 21 per cent. in 1898 to 54 per cent. in 1901, and 52 per cent. in 1902; Germany, 13 per cent.; France fell to 11 per cent. from an average of 27 per cent.; Italy, 6 per cent.; Sweden, 6 per cent.; Austria-Hungary fell to 5 per cent. from an average of 8 per cent.; Belgium, 3 per cent.; United States, 2 per cent.; Switzerland, 2 per cent.

A New Power Station for Johannesburg.

Large Orders for Machinery to be placed.

A COMPANY has recently been formed at Johannesburg for the purpose of erecting a central station to furnish electric power to the mines, and also to supply such demands for public light and power as are not apparently met by the Corporation's own very comprehensive scheme. Some new departure of this kind which would replace the isolated, inadequate, and costly equipments existing at many mines has long been contemplated. The existing equipment of most of the mines in the district is of very obsolete and nondescript type, and, with the present advances in engineering science, could be greatly improved. The scheme is not yet definitely formulated, but we learn on the authority of *The British and South African Export Gazette* that Mr. James Swinburne has been retained as consulting engineer by the company, and that further details will shortly be available.

The Madras Electric Tramways (1904) Limited.

THIS company is organised to purchase the Madras Electric Tramways from the Electric Construction Co., Ltd., of London and Wolverhampton, and to carry on the undertaking. The construction of the tramways was commenced in 1893 by the Madras Electric Tramways Co., Ld., but their capital proved inadequate, and the Electric Construction Co., Ltd., who were contractors for the equipment of the lines, provided the money for their completion. The tramways were completed in 1899 and were purchased in March, 1900, by the Electric Construction Co., Ltd., who have since operated the tramways and successfully developed the traffic. The traffic receipts for January and February of the present year exceed those of the corresponding period of last year by more than 9 per cent., but on the basis of last year's results only, there would be a surplus of £4,080, after paying the interest on £50,000 of debenture stock. The tramways are equipped on the overhead system, and comprise 2¾ miles of double track and 6½ miles of single track, equal to 12 miles of single track, besides about 1¼ miles of turnouts and sidings, with nearly 3 acres of freehold land near the centre of the city, power house, plant and stores. The rolling stock at present consists of 45 motor cars and two trailers.

The Allis-Chalmers Company.

WE learn that the Allis-Chalmers Co. has decided to extend its operations very considerably, and will in future be engaged in the manufacture of steam turbines, hydraulic machinery, gas engines, and heavy electrical machinery, in addition to its well known steam engines. The company is now associated with the Steam Turbine Advisory Syndicate, of this country, and is convinced after an investigation, extending over a period of two years, that it will now be able to produce a steam turbine equal in efficiency and economy to the best make of Parsons, or Curtis, turbines. The company is now prepared to build steam turbines of 500, 750, 1,000, 1,500, and 5,000 K.W. capacity, and if necessary, in units up to 10,000 K.W. The company has concluded arrangements with Escher-Wyss & Co., of Zurich, whereby it becomes the sole licensee for the western hemisphere of their famous hydraulic machinery, several types of which have been installed at the Niagara Falls plant of the Cataract Construction Company, aggregating 85,000 h.p. Having purchased the American patents, and become sole licensee for the western hemisphere, of the Nurnberg Machine Company, of Germany, for its gas engines, the company is prepared to make such motors up to any required horse power, but it is in the blast-furnace trade that the largest business is anticipated. After two years' investigation of various types of gas engine, the company selected the Nurnberg design (see Mr. Allen's article page 359) and is now engaged in its manufacture. The company will also manufacture generators, motors and all kinds of electrical apparatus. The management of the different departments, will be conducted by gentlemen hitherto connected with some of the best electrical works in England and the Continent.

We may add that the Allis-Chalmers Co., has also entered into an alliance with the Bullock Electric Manufacturing Co. The Allis-Chalmers Co. is financially interested as a principal owner in this corporation, and takes over the business as a going concern. In this manner, the Allis-Chalmers Co. is in a position to undertake orders, ranging throughout the entire field of direct-current and alternating-current generating apparatus, Mr. B. A. Behrend, the engineer of the company, having added to the well-known standard line of direct-current motors and generators, rotary converters and some of the largest types of polyphase alternators and synchronous motors complying with the most exacting requirements. Some important changes are being made in connection with the organisation of the company, one of the most important being the resignation of President Charles Allis, whose place will be filled by Mr. B. H. Warren, formerly vice-President of the Westinghouse Electric and Manufacturing Co.

HOME TRADE NOTES.

The following orders have been received by the various firms enumerated below :—

C. A. Parsons & Co. :—Parson's dynamos and turbine at £7,724, Stepney Electricity Committee; 300 h.p. steam turbo-generator, Messrs. Pullar & Sons.

The British Thomson-Houston Co., Ltd. :—Supply of motors for the ensuing year, Ashton-under-Lyne Town Council; 200 volts incandescent lamps, West Ham Corporation; high-tension switchboard at £1,278, Bedford Corporation; 100 type K induction meters, Hammersmith Council.

J. G. White & Co., Ltd. :—Reconstructing Streatham Cable Tramways at £95,005, London County Council; lay-outs at tramway car-shed at £1,359 18s., Derby Town Council; electric tramways and overhead equipment, Wigan Electric Light and Tramways Committee.

Ernest Scott & Mountain, Ltd :—2 400 h.p. engines, Horden Collieries, Ltd., Castle Eden; 1 120 h.p. engine and 1 dynamo, Charlow & Sacriston Coal Co.; 2 300 h.p. steam engines, Moss Bay Hematite Iron Co.; 150 K.W. generator and pumping plant, Stockingford Colliery.

Belliss & Morcom :—One 1,200 h.p. engine for Edinburgh, Dick, Kerr & Co.; 1 585 781 h.p. engine for Belfast, Mather & Platt; 15 engines, 865-1,080 h.p. for H.M. Dockyards, Preece & Cardew; 1 720-864 h.p. engine, British Westinghouse Co.; one engine for 500 K.W. alternator, for Erith.

Babcock & Wilcox :—64 boilers, furnaces, etc., at £100,000, London Underground Railways; 2 boilers with superheaters, British Westinghouse Co.; water-tube boilers at £3,025, Hornsey Town Council; 2 water-tube boilers at £2,300, Battersea Borough Council; supplying and erecting 4 boilers at £9,375, Stepney Electricity Committee.

The General Electric Co., Ltd. :—750 K.W. generating set at £6,435, Aston Corporation; power house plant at £6,298 10s., Hornsey Town Council; 100 volts incandescent lamps, West Ham Corporation; annual supply of electric lamps, etc., Hammersmith Borough Council; electricity supplies for 12 months, Walthamstow District Council.

Bruce, Peebles & Co. :—Six 1,000-E.H.P. direct coupled generating sets; four 100 h.p. balancers and boosters, and 4,000 h.p. in motors varying from 5 to 75 h.p. at £60,000, Chatham Dockyard; power house equipment for St. Thomas and Port Stanley Railway at £42,250, Canadian Electric Traction Co.; 2 turbo-generators, etc. at £13,351, Poplar Electricity Committee; 400-K.W. dynamo, Colne Corporation.

Mather & Platt, Ltd.—400 K.W. set, Belfast Corporation: extensions to 5 500 K.W. sets previously supplied by same firm; 60 b.h p. turbine pump, Battersea Borough Council.

The Brush Electrical Engineering Co.:—20 single trucks for tramcars, Thanet Tramways Co.; 25 tramcars with Brush trucks and B.T.H. equipments, Leeds Corporation; 10 car bodies and trucks, Lanark Tramways (British Thomson-Houston); 15 pairs traction trucks, Cardiff Corporation (British Westinghouse Co.); 6 24-K W. transformers, County of London Electric Lighting Co.; motors for destructor works, Blackpool Corporation; turbo-dynamos, etc. at £3,745; plant for electric lighting installation, Londonderry Asylum; 4 single-deck tramcars, complete with Brush trucks and electric equipment, Auckland Electric Tramways Co.; 300-K.W. dynamo and switch panels, Durban Harbour Board; 6 single trucks for tramcars, La Carrosserie Industrielle, Paris.

British Westinghouse Co., Ltd.:—2 generators, 2 exciters, 9 transformers, 5 motors, 4 motor panels, and 1 switchboard at £15,261, Kalk Bay-Muizenberg Municipality; generating stations at £600,000, London Underground Railways; generating plant, Gwendreath Valleys Anthracite Co.; 720-K.W. generating set at £5,576, Aberdeen Gas and Electric Lighting Committee; equipment for 100 tramcars, Manchester Corporation; 5 bogie cars at £3,008 16s. 6d., Southend Council; 400-K.W. generating set at £3,473, Greenock Corporation; electric power and light installation for pits, South Medomsley Colliery; 12 50-K.W. and 6 18-K.W. transformers, South London Electric Supply Corporation; 12 50-K.W. transformers, Coventry Corporation; 12 months supply of electricity meters, Islington Council; single and polyphase meters for 12 months, Sydney Corporation; 1 100-K.W. gas engine and generator, 1 100-K.W. gas engine directly connected to 2 50-K.W. generators, 1 balancer booster set and 1 switchboard, Sir Hiram Maxim Electrical Engineering Co.

SOME CONTRACTS OF THE MONTH.

Power.

London Underground Railways: Condensers, £25,000; James Simpson & Co. Generating station economisers, £10,000; E. Green & Sons. Piping, £5,000; Widnes Foundry Co.

Ealing Corporation: 750 K.W. Siemens-Paxman steam alternator, £5,811; Siemens Bros. & Co., Ltd. Central surface condensing plant, £2,360; Bertrams, Ltd.

London County Council: Electric jib crane, £3,105 (Greenwich); Ransomes & Rapier.

Battersea Borough Council: Electric pumps and piping, £825; Mather & Platt.

Loughborough Council: Two dry-back boilers, £1,050; H. & T. Danks.

St. Annes-on-the-Sea Urban District Council: 220 K.W. Willans-English electrical manufacturing steam dynamo; Dick, Kerr & Co.

Ipswich Town Council: New generating set, £3,572 10s.; Reavell & Co.

Brighton Town Council: New converter house, cable, culverts, etc., £5,699; Rowland Bros.

Brighton Corporation: 20 ton four-motor overhead travelling crane, £1,100; Glasgow Electric Crane Co.

Lanark County Council: Three-grate "Simplex" refuse destructor, with boiler plant, for Cambuslang Meldrum Bros.

Glasgow Electricity Committee: Six motor generators, £9 958; Electrical Co., Ltd.

Dundee Town Council: Electric generators, £1,500; Thomas Parker, Ltd.

Belfast Corporation: Motor booster and motor balancer; Thomas Parker, Ltd.

Calcutta Electric Supply Corporation: Plant for new station, £40,000; Crompton & Co.

Lighting and Heating.

London County Council Asylums Committee: Annual supply of lamps for Heath Asylum; Sir Hiram Maxim Electrical & Engineering Co.

West Ham Corporation: Annual supply of cut-out boxes; Imperial Lighting Co. Meters; Ferranti, Ltd. Transformers; British Electrical Transformer Co.

Durham County Council: Two 150 K.W. electric light plants, £5,192 10s.; C. A. Parsons & Co.

Salford Town Council; Continuous-current house meters; Chamberlain & Hookham, Ltd.

Wolverhampton Town Council: Annual supply of feeders, distributors, pilot cables, conduits, service boxes and other materials required by the Electricity Department; Callender's Cable Co.

Kilmarnock Corporation: Arc lamps and posts, £1,275 2s. 9d.; Oliver & Co. Mains and feeders, £14,115 8s. 4d.; Callender's Cable & Construction Co, Ltd.

Capetown Corporation and the Table Bay Harbour Board: Supply of paper insulated electric lighting cables; W. T. Henley's Telegraphic Works, Co., Ltd.

Sydney (transferred from Pope, Maher & Co.): Arc lamps, pillars, etc, for public lighting, £10,000; Clyde Engineering Co.

Traction and Transport.

London Underground Railways: Cables, £200,000 British Insulated, Callender's, W. & T. Henley's and other British companies.

West Ham Corporation: Eleven motors, etc., for tramcar shed, £474 17s.; Witting, Eborall & Co.

The New General Traction Co., Ltd.: Two miles of new track and reconstruction of 5½ miles at Coventry, £34,296 19s. 1d.; R. W. Blackwell & Co.

Derby Town Council: Tramway rails; North Eastern Steel Co.

Dick, Kerr & Co.: Extra high-tension feeders for Leeds and Wakefield District Tramways; W. T. Glover & Co., Ltd.

Cardiff Corporation: Tramway rails; Bolckow, Vaughan & Co., Ltd.

Newport Electricity & Tramways Committee: Ten tramcars, £5,046 10s.; Dick, Kerr & Co., Ltd.

New South Wales Government (McArthur & Co.): Duplicate engines for Ultimo power-house; James Howden & Co.

TENDERS INVITED.

Italy.—Tenders are invited until August 18th next, by the Municipal Authorities of Amelia (province of Umbria) for the electric lighting of the town.

South America.—Tenders are required for the electric lighting of the town of Punta Arenas (Straits of Magellan). Tenders by June 28th. All particulars can be obtained at the Chilian Legation, 29 Queen's Gate Terrace, S.W.

Natal.—The Government of Natal invite tenders for the equipment of the ground and first floors of the Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Particulars to be obtained from Sir Walter Peace, K.C.M.G., Agent-General for Natal, 26 Victoria Street, S.W. Tenders to be addressed to the Agent-General or to The Chairman, Tender Board, Pietermaritzburg, Natal, by May 9th.

Melbourne.—The Melbourne City Couucil invite tenders up to 2.15 p.m, May 13th, for the supply and delivery of 1 750 K.W. direct-current steam generator. Specification, etc., from the Agent-General for Victoria, 142 Queen Victoria Street, E.C.

BREVITIES.

Further Germano-American Co-operation.—The American Westinghouse Electric Company have sent one of their representatives to Berlin, in order to discuss the idea of an arrangement with the Siemens-Schukert group, intended to obviate future competition between the American and German firms.

Record Boiler Contract.—Babcock & Wilcox, Ltd., in addition to the contract recently secured by their London house for 18,000 i.h p. for the first-class British battleships "Britannia," "Hibernia" and "Africa," have been awarded through their New York house a large order for the U.S.A. Navy. This comprises 50,500 i.h.p. of boilers for six vessels, one of which, the cruiser "Vermont," will have 18,000 i h p. of boilers. In the "Indiana" eight B. and W. boilers will replace eight Scotch boilers.

Electrification of Tramways at Vera Cruz.—An extensive scheme for the construction of an electric traction system is projected at Vera Cruz, Mexico. It is proposed to electrify and at the same time to considerably extend the existing horse tramway system, which is about eleven miles in length, and is controlled by Messrs. S. Pearson & Son, who have already in hand several large contracts in different parts of Mexico. Sir Weetman D. Pearson is the president of the Vera Cruz Tramway Company.

Opening for Trade at Java.—An American Consular Agent at Batavia reports that there is a good opportunity for an enterprising American company interested in electrical material to make good connections in Java, although it must be prepared to fight German competitors, who are, he is informed, largely interested in the electrical companies established in Batavia. There is not the slightest reason why some of our readers should not make profitable use of this information.

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

* * *

The Electrification of Main Line Railways.

BY THE ASSOCIATE EDITOR.

Since Mr. Langdon read his paper on "The Supersession of the Steam Locomotive" to the Institution of Electrical Engineers more than three years ago, the problem of the electrification of our main line railways has received a good deal of attention, but so far without much practical result. Railway engineers, whose opinions on this matter are of great weight, tell us that it is much too early yet to look for this change, and they assert that those who are purely electrical engineers fail to appreciate the difficulties that must be overcome before the change can be made. We believe there is some truth in this assertion, but on the other hand it is also probable that the railway engineer who has not had practical experience of electric traction, may fail to appreciate fully what has been already accomplished, and may be less than just to his professional brother, the electrical engineer. What is really wanted is that the two classes should work together harmoniously, each helping the other with advice and putting his experience in his own branch at the disposal of his colleague. In this way much more will be accomplished than by idle discussions at meetings of learned societies, which sometimes only tend to give the public erroneous impressions. We do not mean to say that this subject should not be publicly discussed, but only that some of the actual discussions have not been very profitable.

THE LIVERPOOL AND SOUTHPORT RAILWAY.

That something is now being done on the lines we have suggested is proved by the fact that the portion of the Lancashire and Yorkshire Railway between Liverpool and Southport has been actually converted to electric traction and was formally opened to the public under the new system a month ago. This is the beginning of the electrification of our main line railways, and future progress will, no doubt, depend to some extent upon the success of this experiment. A change of this nature is not made simply as a scientific experiment to show what can be done; it is decided upon by business men who expect to be rewarded for their enterprise in improving the facilities of locomotion for the public by receiving increased financial returns. It is the financial test which will determine the rate of progress, and therefore the experiment now begun in Lancashire is of extraordinary interest. If it should fail—but this we believe to be impossible—there will naturally be a check to further enterprise in the same direction; but if it succeeds—as we believe it will—an impetus will be given to the electrification of similar lines in other parts of the country, especially lines branching off at different points from the great railway thoroughfares into the surrounding districts. Suburban railways also must follow the example, and indeed it is already pretty fully recognised that for suburban railway traffic electric traction must ere long be generally adopted. These changes will involve the expenditure of much capital, but when it is shown, as we believe it will be, that such expenditure is remunerative, the public will readily supply the money. A description of the system will be found in the Traction and Transport section this month, on pages 387-8.

LANCASHIRE AND ELECTRICAL PROGRESS.

In connection with this question of the progress of electric traction it is interesting to note the part that is being played by Lancashire. Not only has that county the honour of possessing the first main line electric railway, but it has also the Liverpool Overhead Railway, one of the early efforts of importance in the history of electric traction, and it is to be the home of the Behr Mono-rail enterprise. The Mersey Tunnel Railway has also one end in Lancashire. But besides these railway schemes, the county possesses a very large and intricate network of electric tramways, which are steadily being added to, and which have created quite a new traffic for themselves while at the same time serving at several points as feeders to the railways. In the distribution of electric power, also, Lancashire is well to the front, as the Lancashire Electric Power Company's scheme was one of the four pioneer schemes authorised in 1900. A comparison of the state of affairs in that county at the present time with that prevailing, say, ten years ago, affords an excellent illustration of the rapid rate of electrical progress in this country, and of the great advantages and new conveniences enjoyed by the public as a result of that progress.

L.C.C. AS OBSTRUCTIONIST.

It is difficult to speak in moderate terms of the conduct of the London County Council in its opposition to the North and South Woolwich Electric Railway Bill, which promoted a scheme for a tube railway under the river connecting North and South Woolwich. It was admitted that this scheme, if carried out, would be of great advantage to the working classes in these districts, and that there is a want of some such means of communication between the two sides of the river. Yet the County Council opposed the scheme, not on the broad ground that it was opposed to the public interests, for that attitude was impossible, but on the grounds (1) that the Council, when it purchased the old ferry, had purchased a monopoly, and (2) that the Council hoped to promote a similar scheme for a subway, which might be free to the public, and wanted to be assured that when that scheme is promoted no question of compensation to the present promoters will arise. The first ground of opposition seemed to be a source of uneasiness to the Council itself, for it was put forward in a hesitating manner, and intimation was made that the Council was prepared not to consider this as the *crux* of its case. Yet this idea of monopoly was behind the whole proceedings, and it is well that the public should realise how progress will be delayed if such a notion is allowed to prevail. It is curious to notice how local authorities dilate upon the evil of monopolies when they wish to enter upon some new enterprise of a trading character; yet they are the first to insist on a monopoly for themselves, and even go as far as to create artificial monopolies where—as in this case—there would be room for free competition.

A Prophecy.

The second ground of opposition was more plausible, and had the desired effect on the Committee, which passed the preamble of the Bill subject to the stipulation that the promoters shall not bring forward any question of compensation when the Council comes to Parliament with its scheme. Knowing the powerful influence of the L.C.C. in Parliament, we are not surprised at this result, but we fail to find any reason in the Council's case to make that decision appeal to us. For their own witness, the Vice-Chairman of the Bridges Committee, had to admit that the Council, as yet, had no definite scheme for a subway, and could not pledge his word that the Council will promote such a scheme. That is to say, the whole matter is brought forward for purposes of opposition, and, in consequence, the workers of Woolwich must do without this convenience till it pleases the Council to do something for them. We are not fond of prophesying, but we venture in this case to say that if the Council does in the future promote a scheme for a subway, it will be done by them as traders owning tramways, and for the purpose of linking up tram lines on the two sides of the river. Foot traffic and ordinary vehicular traffic, if provided for at all, will be subsidiary to tramway traffic, and it is in order to keep the ownership of travelling facilities as much as possible to themselves that this obstructive opposition is brought forward. Such tactics are far from creditable; but they do not surprise us when we remember the deplorable conduct of the Council on the question of tramways across the Hammersmith Bridge.

PARLIAMENTARY MATTERS.

Marylebone.

The House of Commons Committee which considered the Marylebone Bill asking for powers to borrow the money required by the Borough Council to pay the Metropolitan Supply Company the amount awarded by the arbitrator, on March 24th, found the preamble proved, but with certain important amendments. In the first place, the Borough Council desired to be allowed a period of forty-two years in which to repay the loan, and claimed that there were special circumstances to justify this long period. The Committee, after hearing evidence on this point from the Local Government Board, granted a period of thirty-eight years.

No Powers to Lease.

But a much more important amendment than this was made by the Committee. It will be remembered that negotiations had been going on between the Borough Council and the General Electric and Westinghouse Companies, which, if completed, would have resulted in one of these companies undertaking the construction and erection of the necessary works for the Council's own installation, receiving in return a lease of the undertaking for a definite period. The exact terms of the offers of the two companies need not now be discussed. To enable the Council to make some such arrangement, a clause was introduced into the Bill giving the Council power to make agreements with a company regarding their undertaking. This was opposed by the Metropolitan Company and by the Gas Light and Coke Company, and after full discussion the Committee ordered the clause to be struck out. Thus the Council is now bound to carry on the work of supply by itself from the outset, and the outlook for the ratepayers is all the more serious. Under the circumstances we should have felt that the Committee had done wrong in this ruling; but when we remember that the whole question has arisen from the foolish desire to buy out a company, it is but right that the community should be made to realise the weight of the burden it has taken upon itself, and it would not have been fair to the Metropolitan Company for Parliament to allow the council simply to replace it by another company, and so get rid of the difficulties it has brought upon itself. The effect of the decision may be sore upon the ratepayers, but they are to blame for ever allowing their civic rulers to enter upon this mad enterprise.

An Important Precedent.

The passing of the preamble of the Tyneside Tramways and Tramroads Bill is of more than local importance, as it involves the acceptance by a Parliamentary Committee of a proposal to grant powers to a private tramway company to run its cars over an adjoining municipal system. That the preamble was passed without amendment of the Bill is in itself of great importance, but that it was passed in spite of the opposition of such a powerful local authority as Newcastle-on-Tyne is both significant and encouraging. The lines of the Tyneside Company end at present at the boundary of Newcastle-on-Tyne on the South Shields side, and the company asked powers to run its cars over the municipal lines, giving the Corporation in turn the right to run over the company's lines. The arrangement proposed in the Bill is that none of the fares collected by the company in Newcastle shall be retained by the company beyond an amount snfficient to pay working expenses, and a similar arrangement will hold good for the Corporation on the company's lines. There was a good deal of talk about the want of "precedents" for forcing such an arrangement upon a local authority, but Mr. Balfour Browne, with his usual boldness, plainly stated that he did not mind whether there was a precedent or not, and that if such a thing had never been done before, it ought to be done now, because it was in the public interest. We congratulate the Committee—by the way, a House of Lords Committee—on taking this view, as it is undoubtedly in the interests of the public to encourage through-routes, and indeed one of the greatest objections to municipal operation of tramways is the difficulty it places in the way of arranging through-routes. We sincerely hope this precedent may soon be followed in other cases.

The Soothill Nether Case.

The decision of the House of Commons Committee on the Soothill Nether Urban District Tramways Bill is also of great interest from the point of view of this question of through-routes. On either side of the district there are tramways owned by companies, and the Urban District Council now sought powers by this Bill to construct lines in its own area. The Bill was opposed by the Wakefield District Light Railway Company, which owns lines on the Wakefield side of Soothill Nether, on the ground that it is now applying to the Light Railway Commissioners for powers to construct practically the same lines to link up with its present system. The Urban District Council seems to have been unable to make up its mind whether to work the proposed lines itself—a ridiculous enough idea for a small system of 2½ miles of track, sandwiched between two larger systems!—or to lease them to a company; but the Committee, in pressing the preamble of the Bill, has settled this matter once and for all by requiring the Council to lease the construction of the lines, and also their operation for a period of not less than forty years. Profits derived from the lease are to be set aside as a sinking fund till the amount accumulated equals the original cost of construction. It is most satisfactory to find a Committee departing in this way from the somewhat stereotyped rule of allowing every local authority that cares to ask for powers, to work its own tramways without any regard to the necessity of providing through-routes.

The Position at Birmingham.

The difficulties thus raised by municipalisation of tramways are likely ere long to be very clearly shown at Birmingham. At the recent meeting of the City of Birmingham Tramways Company the Chairman pointed out the inconvenience that must be caused to the public by the action of the Corporation in taking over the city lines, as this involves a break in the routes at the boundaries of the municipality, the lines beyond the municipal area being still worked by the company. This result was foreseen long ago by the company, and the advantage of these through-routes was impressed upon the public when the agitation for municipalisation was on foot, but all to no purpose. The inconvenience to those using the cars, however, will not be the only serious consequence; the financial success of the Corporation cars must also be seriously affected. When one looks at the map of the network of tramways in that district, one feels more than ever convinced that a great mistake has been made, and that the Corporation would have been well advised to accept the terms offered by the company for a new lease. At present, however, the craze for municipalisation must be allowed to run its course.

Swansea Tramways.

The tramway situation at Swansea has recently been the subject of investigation in the law-courts, and is certainly extremely interesting. The lines there are worked by a company, and the extensions for which the Corporation has received powers are also to be leased to this company. The question has arisen, however, as to the rights of purchase possessed by the Corporation. That body maintained that it had the right, under the Tramways Act, to purchase the whole of the company's system in 1906, without being thereafter required to lease the lines or any portion of them to the company. The contention of the company, on the other hand, has always been that only one section is purchaseable in 1906, that the other sections become purchaseable at different dates; that the Corporation is bound, upon purchasing this section in 1906, to lease it to the company for 21 years; and that no other section can be taken over by the Corporation while any lease exists. Mr. Justice Buckley has now declared this view to be the correct interpretation of the Acts, and the result must be to strengthen very materially the position of the Swansea Improvements and Tramways Co.

FINANCIAL NOTES.

The Conflicting Interests of Local Authorities.

A CURIOUS sidelight on some of the effects of municipal trading may be found in a recent quarrel between the Glasgow Corporation and the Caledonian Railway Company. The company is making very extensive alterations at its main station in Glasgow, and wanted the consent of the Corporation for the erection of a high roof over the station, part of which is on a bridge across a main street. The Corporation would not allow a greater height than 18 ft. for this roof, whereas the company wanted a height of 54 ft. Now, the Corporation generating station at Pinkston, which supplies energy for the tramways, is built on a canal belonging to the railway company, and water is taken from the canal for condensing purposes; so the company recently gave notice to the Corporation that the right of using the canal water would be withdrawn after a certain date. There is no other means at hand of getting water, and to erect water towers would not only require time, but would cost £20,000 to the Tramways Department. Of course, this notice from the company caused consternation in Corporation circles, and at first members indulged in heroics, declaring that they would not "take it lying down," and daring the company to do its worst. But after a little, calmer counsels prevailed, and negotiations with the company were opened. The outcome is that an agreement has now been made between the Corporation and the railway company, whereby the company is allowed to build its roof to the desired height and the Corporation is allowed to continue to use canal water. Between trading companies this would be called a "deal," and would be quite proper; but when one of the parties is a public authority, whose attitude on the matter of the roofed bridge was adopted in the interests of the community, which does not desire to have the appearance of its principal streets made ugly, then the situation is altered. Here we find a great Corporation willing to sacrifice the public interest and all questions of architectural beauty because—to quote the convener of the Tramways Committee—"if they refused the company's request they would involve the Tramway Department in an expenditure of £20,000 for water towers and the necessary machinery." This conflict between the proper duties of a local authority and their interests as traders becomes more acute with every new venture, and we doubt not that we shall in the future find many cases like that with which we are now dealing.

Some Dividends.

THE following are some of the annual ordinary share dividends announced by electrical companies last month:—

1. *Lighting.*	
City of London Electric Lighting Co.	5 per cent.
Metropolitan Electric Supply Co.	8¾ ,,
Chelsea Electric Supply Co.	5½ ,,
South London Electric Supply Corporation	3 ,,
Hove Electric Lighting Co.	8½ ,,
Newcastle-upon-Tyne Electric Supply Co.	8 ,,
Bournemouth and Poole Electric Supply Co.	8 ,,
Cambridge Electric Supply Co.	7 ,,
Northwich Electric Supply Co.	3 ,,
2. *Tramways.*	
City of Birmingham Tramways Co.	10 ,,
Tynemouth and District Electric Traction Co.	7½ ,,
Oldham, Ashton, and Hyde Electric Tramway	7 ,,
Greenock and Port Glasgow Tramways Co.	6 ,,
Devonport and District Tramways Co.	4 ,,
Swansea Improvements and Tramways Co.	2½ ,,

It is noteworthy that in the case of two of the London lighting companies mentioned above—the Metropolitan and the Chelsea Electric Supply Companies—in spite of trade depression and other causes affecting revenue returns, the dividends are actually higher than those for the previous year by 1¼ and 1 per cent. respectively.

Glasgow Corporation.

THE Electric Lighting Department of Glasgow Corporation promises this year to give satisfactory returns for the first time since its inauguration. The financial year does not close till the end of May, but already the returns are such that the Committee has felt justified in deciding to pay off the debt of £13,895 6s. 1d. borrowed from the Gas Department last year to make good the deficit on the electric lighting undertaking at May 31st, 1903. This large deficit was partly due to the loss on the sale of plant at the abandoned Waterloo Street station.

THE Telephone Department of this Corporation has lately been much criticised, and the critics will find justification for many of their remarks in the fact that the necessity has already arisen for further capital expenditure amounting to £50,000, for which sum the Secretary for Scotland has now authorised a loan.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A., 78 Fleet Street, E.C.

Regulating Devices for Electrically Propelled Vehicles.

John Smith Raworth, Streatham Hill, Surrey. No. 3657. Dated 16th Feb. 1903.

This invention has for its object the simplification of the controller of electrically propelled vehicles, and is applicable to direct current motors.

Claims.—(1) In a regulating device for vehicles propelled by electric motors, the combination with motors with a shunt field winding, of means for controlling the field circuit, means for controlling the armature circuit, and interlocking means so arranged that the armature circuit cannot be made or broken until the field circuit controlling means are in a certain position.

(2) A regulating device, with a shunt winding, wherein the means by which the armature circuit is closed or opened and the means which regulate the strength of the shunt excited fields, and thus govern the speed of the vehicle, are interlocked in suchwise that the armature circuit cannot be opened or closed until the fields are excited to a maximum.

(3) A regulating device wherein a speed lever and a power lever are so interlocked that when the armature circuit is closed, the speed lever can be moved through the full range of regulation and vary the motor fields to suit the speed required, but not so far as to break the field circuit, and when the armature circuit is open the speed lever can be moved to a greater extent, so as to break the field circuit.

(4) A regulating device wherein the speed lever carries a pin that engages with slots in the power lever, the arrangement being such that according to which slot the pin on the speed lever is working in, the armature circuit is locked open or closed, or the power lever is released to allow the condition of the circuit controlled thereby to be changed.

(5) In a regulating device for vehicles propelled by electric motors of the kind herein referred to, a plate carried by the power lever for interlocking the speed lever and the power lever, said plate having three slots therein which are adapted to be successively engaged by a pin on the speed lever in suchwise that when the pin is in one slot the armature circuit is locked closed, and the speed lever prevented from breaking the field circuit, and when the pin is in a second slot the power lever can be moved, the speed lever then being held immovable, and when the pin is in a third slot, the the power lever is so held that the armature circuit cannot be opened, but the speed lever can be moved so as to open the field circuit, and, when moved to such position, be held.

(6) A regulating device having a series winding as well as a shunt winding wherein the series winding is normally short circuited, the arrangement being such that the short circuit cannot be removed except when the shunt field is very strong, substantially as described.

(7) Regulating device arranged and operating substantially as described and shown in the drawings.

(8) A plate for interlocking the circuit controllers of motors.

(9) The combination with the interlocked speed and power levers of the regulating device hereinbefore described of a braking handle and a cam surface so arranged that the cam surface prevents the said handle being actuated to remove the short circuit on the series winding except when the speed lever is in such a position that the shunt field is very strong.

Motors and Regulating Devices for Electrically Propelled Vehicles.

John Smith Raworth, Streatham Hill, Surrey. No. 3658. Dated 16th Feb., 1903.

The object of this invention is to return electrical energy to the line in descending gradients, and in arresting the motion of the car.

Claims.—(1) A regulating device for motors having two field circuits controlled by two connected handles or levers, one of which is normally forced into a position in which a switch controlled thereby short circuits the series field winding.

(2) In a regenerative motor control system for electrically propelled vehicles, the combination with motors having both shunt and series field windings, of means for controlling said shunt field circuit, means for controlling said series field circuit, means for controlling the armature circuit, and means for interlocking the armature circuit and shunt field controlling means, said series field circuit being normally short circuited and adapted to be placed in circuit and augment the field when the motor is returning current to line.

(3) In a regenerative motor control system for electrically propelled vehicles, the combination with motors having both shunt and series field windings, said series winding being normally short circuited, of means for controlling said shunt field winding, means for removing the short circuit on said series field circuit, means for controlling the armature circuit and means for interlocking said shunt field and armature circuit controlling means, a circuit connecting one side of said motors with the earth side of said series winding, a normally open switch in said circuit, said switch being adapted to be closed automatically and short circuit the motors on themselves when the shunt field and armature circuits are open.

Improvements in or connected with Coin Freed Electricity Meters.

Frederick John Beaumont, Stroud Green, Middlesex. No. 17721. Dated 15th Aug., 1903.

This invention relates to mechanism connected with coin freed electricity meters, in which the meter operating mechanism is relieved from the strain or work required for gradually and finally cutting off the supply of electricity after a predetermined amount of current has been delivered.

The invention chiefly comprises a combination of a movement which can be wound up after the insertion of a coin or coins in the apparatus, the amount of winding up being capable of variation by the employment of a clutch and a price changer wheel in connection with a coin pocket wheel whereby the winding is effected in one direction, when said coin pocket wheel is turned as far as a fixed stop, the movement being free to return in the reverse direction, but controlled by a worm wheel and worm attached to an extension of the central shaft of the meter mechanism.

Claims.—(1) The improvements in or connected with coin freed electricity meters, consisting of the combination with said meters of a clockwork movement which can be wound up in one direction for the supply of current after the insertion of a coin in a coin freed mechanism, the amount of winding being variable by the employment of a clutch and a price changer wheel, and the movement being free to return to gradually cut off supply under control of a worm on an extension of the meter mechanism.

(2) In combination with coin freed electricity meters the employment of the "dimming" and cut off arrangement, consisting of a pivotted lever, one end of which passes over suitable contacts and the other end successively engaging notches on the periphery of a controlling disc.

An Improved Method of Melting Steel and the like in Electric Furnaces.

Alleyne Reynolds, London. No. 11,002. Dated 14th May, 1903.

This invention relates to an improved method of melting steel and like materials in which a slag is formed which is inert to the charge and to the electrodes at the temperature to which these are to be subjected and the said slag is then maintained at a high temperature by the passage of an electric current through it or by arc or arcs formed between the electrodes and the slag and the steel or other material melted by the head of the incandescent slag.

A convenient form of furnace for carrying out the method consists of a circular casing mounted on trunnions and lined with refractory material having preferably an eliptical interior which is covered with a refractory acid or basic lining according to the nature of the charge to be treated. A tap hole is provided above the level of the bottom of the crucible. The electrodes may conveniently consist of two carbon blocks capable of being raised or lowered together over the mouth of the crucible.

The composition of the slag will vary with the character of the crucible lining and the operation to be performed, but in every case it must consist of a material or mixture which remains inert to the charge and to the electrodes at furnace temperatures. If, for example, the crucible has an acid lining, a few turnings of iron to form a conducting bridge between the electrodes together with some sand, carbon, and lime are added to the charge and a current passed through them from one electrode to the other. Silica, lime, and carbon are added until a considerable quantity of a very acid silicate of lime slag has been obtained, such a slag having no serious chemical effect on the charge or the carbon electrodes which are thus preserved from wear themselves and from contaminating the charge.

Claims.—(1) The herein-described method of melting steel or the like by forming on the surface of the charge, and maintaining at a high temperature by means of an electric current or electric arc, a slag which is chemically inert to the charge and to the electrodes.

(2) The herein-described method of melting steel or the like in an acid lined crucible by forming electrically on the surface of the charge a slag consisting of an acid silicate of lime, and maintaining the said slag at a high temperature by the passage of an electric current.

(3) The herein-described methods of melting steel or the like in a basic lined crucible by forming electrically on the surface of the charge a slag consisting of a basic silicate of lime or of magnesia or of lime and magnesia, and maintaining the said slag at a high temperature by the passage of an electric current.

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers will be given.

SHORT NOTICES.

The Story of Electricity; J. Munro. **The Story of Rapid Transit;** B. Willson. George Newnes, Ltd., Strand, W C. 1s. each. Both these little volumes contain interesting information and give popular accounts of the subjects they deal with.

Who's Who Year Book, 1904; 1s. net. **English Woman's Year Book, 1904;** 2s. 6d. net. **Who's Who, 1904;** 7s 6d. net. Adam & Charles Black, Soho Square, London. The above are welcome and valuable additions to our works of reference.

Elektrische Apparate fur Starkstrom.

By GEORG J. ERLACHER, Gebrüder Jänecke, Hannover, 1903. Price 8 marks.

This useful book of 230 pages is devoted entirely to the design and details of construction of switchboards, switchboard accessories and switch-gear. Part I. deals with the general principles of switch construction, and contains fully illustrated descriptions of the leading types of high and low tension switches. Part II. is devoted to fuses. Part III. to automatic maximum and minimum circuit breakers. Part IV. to accumlator switches, Part V. to rheostats, and the concluding Part VI. to complete switchboards. The book is illustrated with a very large number of scale drawings, and the principles of design and methods of calculation are in each case gone into very thoroughly and fully.

Trade Unionism and British Industry.

A reprint of *The Times* articles on "The Crisis in British Industry," with an introduction by Edwin A. Pratt. London. John Murray. 1904. Price 5s. net.

Whatever opinions may be entertained with regard to the future fiscal policy of this country, all who are intimately acquainted with the working of trades' unions will probably agree that these organisations do much to render successful the severe competition of our foreign rivals. In this work the author discusses the policy and practice of the trades' unions with much freedom and vigour, and suggests reforms that would be of incalculable advantage to British manufacturers and workmen alike. In the first place, he urges that the restriction of output policy should be abandoned by the unions, and in the second place that these bodies should employ their energies to improving the organisation of foreign labour, so as to increase the cost of production for foreign manufacturers. If trades' union leaders could only be persuaded to be sensible, simple remedies such as these could be applied at once, and with much advantage to all concerned.

Railways.

By E. R. McDERMOTT, Joint Editor of the *Railway News*, and City Editor of the *Daily News*. London: Methuen & Co. 1904. Price 2s. 6d.

After a historical sketch dealing with the development of the railway system in this and other countries, the author places before his readers what we may designate a series of articles on rates, administration, and other matters connected with railways. Many points discussed are of extreme interest to traders, but the method of treatment adopted throughout is such that this work will probably appeal more to the general public than to business men who are already acquainted with the working details of the railway system. The concluding chapter on "The Future of Railways" might have been made particularly useful to some of our readers, but it is very brief, and includes nothing that is not already perfectly familiar to them. The book is well written, and as an account of railway work is distinctly interesting.

Gas and Oil Engine Management.

By M. POWIS BALE, M.I.Mech.E., A.M.Inst.C.E. London: Crosby Lockwood & Son. 1903. Price 3s. 6d.

This volume is essentially a series of notes on the selection, construction, and management of internal combustion motors, but, referring to the question of selection, Mr. Bale advises his non-technical readers to take the guidance of an expert qualified to express a reliable opinion as to the suitability of different engines for the work to be done. The fixing of gas and oil engines, water cooling and gas supply pipes and apparatus are suitably dealt with, and some serviceable notes are given upon the defects and failures, as well as upon valves, ignition, pistons, rings, and other working parts of such engines. The work is eminently practical in character, and owing to its sub-division into paragraphs should be found very convenient for reference.

Protection and Industry.

By VARIOUS WRITERS. Methuen & Co., London, 1904. Price 1s. 6d. net.

In this book we have a useful collection of writings, which originally appeared in the columns of our contemporary *The Manchester Guardian*. The articles now reproduced represent the views of the modern Free Trader, who seems no longer to adhere to the theories of Cobden as to reciprocal free trade, but honestly believes what is often termed "one-sided" free trade to be good for the country. Although the arguments here put forward may not meet with universal approval, there is no doubt that the articles express many opinions with which all will agree. We may particularly refer to the contribution by Mr. Wadham, on "Machinery and Engineering," as one well worthy of careful consideration, and we are quite in accord with the sentiment expressed in the preface that if the present discussion can be turned in the direction of encouraging the application of more skilful and highly-trained intelligence on the part of employers, workers, and others engaged in industry, lasting and immeasurable good may be the result.

Logarithms for Beginners.

By Charles N. Pickworth. Whittaker & Co. Price 1s.

The author states that the purpose of this little book is to give a more than usual detailed and practical explanation of logarithms and their various applications. In all branches of applied science logarithms are of great service, not only in reducing the labour attending the numerous calculations, but also in simplifying the solution of complex problems. The fact that the book is intended for beginners leads one to expect simplicity of treatment, and we do not remember a work on logarithms, which is characterised by such clearness, thorougness, and usefulness, as the one under review. A special feature of the book is the large number of typical examples which are fully worked out, and it is not too much to say that no point which presents any difficulty is overlooked. This is particularly evident in the case of negative characteristics, a whole chapter being devoted to elucidate this somewhat difficult part of the subject. A large number of exercises are also included to afford practice for the student.

Imperial Union and Tariff Reform.

By The Right Hon. Joseph Chamberlain, M.P. Grant Richards, London, 1903. Price 1s. net.

Whatever opinions may be entertained as to the proposals now being made for Fiscal Reform, all who desire to look at matters from a thoroughly impartial point of view will welcome the opportunity afforded in this pamphlet for reading at leisure the various speeches delivered by Mr. Chamberlain between May and November, 1903. Reports presented by newspapers are not invariably free from errors, and it is frequently the case that the speaker himself may use expressions on the spur of the moment, which do not precisely convey the intended meaning. In the present reprints, the author has taken the opportunity of making such corrections and modifications as appeared to be necessary, and as now presented the speeches fully describe the objects of tariff reformers, and the means by which they hope these objects may be best attained. Of course, the pamphlet to which we refer is purely argumentative, but it will serve as a useful introduction to statistics and details obtainable from other sources.

Telephone Lines.

By W. C. Owen. London: Whittaker & Co., Paternoster Square. Price 5s.

One of the many obstacles which handicap telephone development in this country is the absence of practical handbooks enabling young telephone engineers to qualify themselves in their profession. The present work is, therefore, to be welcomed as being a valuable contribution to telephonic literature. It is written by a practical man whose experience well qualifies him for the work. Divided into two sections, it deals with the principle of overhead and underground construction. In view of the "passing" of aerial lines less space might have been devoted to the former to the advantage of the latter. A further economy would have been effected in omitting some texts and illustrations of Continental overhead methods, which are only of comparative interest and of little utility to the student. In the event of a new edition being issued, the value of the work would be enhanced by

(1) The sub-division of chapters with proper headings.
(2) Copies of specification of material and work.
(3) Index to the various tables.
(4) A chapter dealing with costs of construction.

The last chapter could be somewhat curtailed so as to deal specifically with such electrical tests as are essential during and after the completion of telephone lines, while a simple means of testing wires for induction would be useful. As it is, the book is to be highly recommended, and should be in the possession of all telephone engineers.

The Common Sense of Municipal Trading.

By Bernard Shaw. 1904. Westminster: Archibald Constable & Co., Ltd. Price 2s. 6d.

In this little volume we have presented to us the common sense of municipal trading as it appears to Mr. Bernard Shaw, but we doubt if he will find others to take the same view. The book is interesting, and at times even amusing, and like all Mr. Bernard Shaw's works it is excellently written. But it cannot be accepted as a serious discussion of the question at issue. If Mr. Shaw followed out his own argument to its logical conclusion, he ought to be among the opponents of municipal trading as now carried on, for he says (p. 19) that "the desirability of municipal trading is actually in inverse ratio to its commercial profitableness." This is exactly the view taken by anti-municipalists, and if Mr. Bernard Shaw has not realised that it is the hope of making profits for the relief of rates that has led to the enormous growth of municipal trading, we fear he has yet much to learn. A large part of the book has really no direct bearing on the question, and with much of it even the despised advocates of private enterprise will cordially agree, so that, in so far as it is intended to convert the public to municipal trading, we fear it has failed in its object. But as an attractive essay by a brilliant writer on "the most succulent subject in the whole range of literature," the book is worth reading.

Refuse Disposal and Power Production.

By W. Francis Goodrich. 1904. A. Constable and Co., Ltd., Whitehall Gardens, S.W. Price 16s. net.

This book, which is a very distinct advance on a previous and widely read work from the same pen, deals with the history and modern development of the refuse destructor, particularly with regard to the utilisation of the available steam power and bye-products of combustion. Starting from the sound basis, that the destructor is a necessity of modern municipal management, the author shows, by solid and convincing arguments drawn from plants actually at work, how the working expenses may be set off by the returns, and the heavy burden of refuse disposal by crude and old fashioned methods largely lightened. Useful warnings are given against the wiles of the quack inventor, who is to be found in this as in all other branches of engineering work, and whose efforts are frequently prejudicial to real progress. The author is to be congratulated on the fair and candid manner in which he deals with the merits of the different systems of refuse destructor, and while we cannot agree with all his conclusions, we can appreciate his painstaking effort to put before his readers the necessary facts. The book is full of information valuable alike to the designer, purchaser, and superintendent of refuse destructor and steam power plants. Where quotations are introduced, the source is fully indicated, and there is an excellent index. Of course, persons making a serious enquiry should not confine themselves to any one book, but should get information first hand; but with this *proviso*, we can recommend the book with confidence to every one interested in its subject, and we hope it will have the wide circulation which its merits deserve.

Continuous Current Dynamos and Motors.

By W. R. Kelsey, B.Sc., A.Inst.E.E. London: Technical Publishing Co., Ltd., 1903. Price 5s.

We can confidently recommend this book as a simply written and thoroughly practical introduction to the study of continuous current machinery. Very little knowledge is assumed by the author on the part of the reader, and few, we think, will find any difficulty in reading the book. The first four chapters deal with general principles. The method of approximately calculating the ampère-turns for various arrangements of magnetic circuits, and the main facts relating to the magnetic behaviour of iron and steel, are very clearly explained, and the treatment is thoroughly up-to-date. There are, of course, various little slips and inaccuracies, which, however, it is hardly worth while criticising, as they do practically no harm in a book intended for beginners. (We refer to such statements as that magnetic force is measured in *dynes*; it is, to be quite correct, measured in *dynes per unit pole*, so that its dimensions are not those of an ordinary dynamical force.) The description of a ballistic galvanometer given on page 49 refers to a thoroughly antiquated type: no experimenter who knows his business would nowadays dream of using any other form of instrument than the moving-coil type, which is not even mentioned by the author. The study of dynamos is taken up in chapter V., and the various forms of armature windings are rendered very clear by the aid of numerous diagrams and winding tables. The chapter on motors (chapter XIII.) is deserving of special notice, as both the construction and methods of speed control are explained much more fully and clearly than is generally the case in elementary text-books.

Specielle Elektrochemie.

(Special Electro-Chemistry.)

By H. Dauneel. W. Knapp, Halle, 1903. Price 3 marks.

This is the first part of one of the sections of the Handbook of Electro-Chemistry which is to appear in instalments as ready. The section entrusted to Dr. Dauneel, under the title of Special Electro-Chemistry, will deal with the electro-chemical production and electrolysis of the various elements and their inorganic compounds, and will be completed in about fourteen parts. The present instalment deals with hydrogen and some of its compounds, and the subject is treated in the most exhaustive manner. A most valuable feature is the care taken to give due credit to every worker who has contributed, in however small a degree, to the advance of knowledge in the field traversed. A footnote reference to the original appears to be given in every case, and these references include technical and purely scientific publications and patent specifications in German, French, English, Italian, and Russian. A few misprints occur in these, *e.g.*, engineer and engineering are invariably spelt engeneer and engeneering. A footnote on page 48 gives a reference to Lond. Proc. Soc.; we presume Lond. Proc. Royal Soc. (Proceedings of the Royal Society, London) is what is intended. These are small faults, but they are the only ones we have noted. For the general treatment of the subject we have nothing but praise, mingled with wonder at the enormous amount of labour involved in the production of such a work.

Die Elektrolyse des Wassers.

(The Electrolysis of Water.)

By V. Engelhardt, W. Knapp, Halle. Price 5 marks.

This is the first of a series of monographs on applied electro-chemistry published by this firm, by a chief chemical engineer in Messrs. Siemens and Halske's works. After a historical introduction, a short chapter of a couple of pages is devoted to the consideration of the various constants to be considered in the electrolysis of water. The third chapter, which comprises the greater part of the volume, deals with the various processes in use for the electrolytic production of oxygen and hydrogen separately and mixed together respectively, and for the electrolytic production of oxygen alone, laboratory and commercial methods being separately treated. The fourth chapter deals in the first place with the question of capital and current costs, after which various practical points are discussed, such as anode consumption, the absorption of carbonic acid, and the methods of securing immunity from explosions. The remainder of this chapter is devoted to the consideration of the principal commercial uses of the mixed gases, and of oxygen and hydrogen separately. A series of useful tables is given in an appendix. Numerous references are given to the original sources of information. If the succeeding volumes of the series come up to the standard of the present one, it should be of the utmost value to all who are interested in commercial electro-chemistry.

Testing of Electro-Magnetic Machinery and other Apparatus.

By Bernard Victor Swenson, E.E., M.E., and Budd Frankenfield, E.E. Volume I.—Direct Currents. New York: The Macmillan Company. London: Macmillan & Co., Ltd. 1904.

In every sense of the term this is essentially a practical work, and should be appreciated by students as well as by practising engineers. The bulk of the treatise is devoted to tests, but the attention of our readers should be particularly directed to the admirably arranged preliminary sections of the volume. First, we have a convenient table of the nomenclature employed by the authors, followed by a list of references to sixty-six standard works on electrical practice. Then come a list of the experiments described in the body of the treatise, and a short prefatory section in which are explained the general methods to be adopted in testing work, and the essential features that should characterise every report, the form and scope of which are well illustrated by a sample report. Indicating instruments used in the laboratory are then briefly described, classified, and illustrated. Coming now to the section "Experiments," we find the treatment of each test is entirely self-contained, the following being the sequence adopted: (1) a review of the theory involved; (2) a description of the particular experimental method adopted; and (3) practical applications of the particular subject chosen. The experimental observations required are enumerated under the heading of "Data," and questions bearing directly upon the subjects selected are propounded at the end of many of the experiments described. The last mentioned feature should be of considerable value to students. Appendix A, relative to "Shop Tests," is more especially addressed to those interested in the testing department of a manufacturing establishment, and Appendix B, containing the standardisation report of the American Institution of Electrical Engineers, will be read with particular interest at the present time when standardisation is so prominently before the electricians of this country. In a brief notice, such as the present, we are reluctantly compelled to abstain from detailed comment, and must refer our readers to the work itself, which we feel sure will be generally welcomed by the electrical profession.

The Dynamo.

By C. C. Hawkins, M.A., M.Inst.E.E., and F. Wallis, B.A., A.M.Inst.E.E. Third Edition, Revised and Enlarged. London: Whittaker & Co., 1903. Price 15s.

The third edition of this well-known work is an immense improvement, in every way, on the first two editions. By a drastic application of the weeding-out process, and the inclusion of much new matter, the authors have effected a transformation which at once places their work in the front rank of up-to-date advanced text-books.

The general plan of the work may be briefly outlined. The first five chapters deal with general principles, and will probably be considered superfluous by the reader who is sufficiently far advanced to profit by the remainder of the book; but the plan of making the book entirely self-contained has much to recommend it, and we cannot blame the authors for having retained these introductory chapters. In chapter VI. we have an outline of alternate current theory, which, no doubt, is intended as an introduction to that section of the work dealing with alternators, and to the theory of commutation. The detailed technical study of dynamos is commenced in chapter VII., and is continued throughout the next five chapters. The various types of armature windings are very clearly explained. Chapter XII. is a digression on the magnetic circuit. The mechanical construction of armatures is dealt with in chapter XIII., and field magnets and their windings in chapters XIV.-XVI. The next two chapters, which are among the best in the book, deal with the important question of armature reaction and commutation. Chapter XIX. deals with the heating of dynamos, chapter XX. with dynamo design, and chapter XXI. with the working and management of dynamos. The remaining chapters, XXII.-XXVI., are devoted to alternators and to descriptions of typical machines. We may say that this concluding portion of the book is particularly valuable, as it gives in a reasonable compass a good digest of the large amount of work that has been done within recent years on the theory of alternators; much of the information contained in it is not to be found in any other text-book.

We have nothing but praise for the thorough manner in which the work of revision has been carried out. Attention may be drawn to the heading of section 2, page 2, which should read: "Electrical *power* and its two factors, E.M.F. and current," and not "Electrical *energy*. . . ." Again, we wish the authors did not persist in using the term "inductor" for what everybody else calls "conductor," especially as their lead in this matter has not been followed by other writers, and as "inductor" already has a well-known and generally accepted technical meaning.

(1) Introduction to Study of Physical Chemistry. 1/-

(2) The Phase Rule and its Application. 5s.

By Sir William Ramsay, F.R.S., and Alex. Findlay, D.Sc.

The former book is the general introduction to the series of text books on physical chemistry, edited by Sir William Ramsay, who is the author of the first of the books under review. As is well known, the progress and development in the various branches of physical chemistry has been most marked, and Sir William Ramsay, in the space of 48 pages, has been more than usually successful in presenting an outline of the various stages of progress which has formed the foundation of the whole subject of physical chemistry. Not only is it interesting historically, but it is a valuable exposition of the theories respecting the structure of matter and the laws of nature which have been evolved from time to time. Although a difficult subject, the author has presented his matter in so simple a manner that the ordinary student may read the book without encountering serious obstacles. It is such a book that every student of physics should read and read again.

The second volume, which treats of the phase rule, is the first of the series dealing with its subject from the specialist point of view, and treats of only one branch of physical chemistry. The phase rule was first propounded by Willard Gibbs, Professor of Physics in Yale University, who showed that all cases of chemical equilibrium could be surveyed and grouped into classes, and how similarities in the behaviour of apparently different kinds of systems, and differences in apparently similar systems, could be explained. It may be mentioned that ice, water, and vapour, are three phases of the same chemical substance—water. Mr. Findlay treats in a very able manner the subjects of solutions, equilibria between two volatile components, solid solutions, crystals, etc., and physical literature is the richer for his contribution to this branch of physical chemistry.

Modern Engines and Power Generators.

A Practical Work on Prime Movers and the Transmission of Power (Steam, Electric, Water and Hot Air), by RANKIN KENNEDY. Vol. I. London: The Caxton Publishing Co., Chancery Lane, E.C. Price 9s.

This work, of which Vol. I is before us, comprises a series of volumes dealing "not only with engines of modern design or invented in recent years, but also with engines found to serve useful and efficient purposes at this date. Many old devices have survived and are worthy of a place when presented in their more modern developments." Volume I. opens with an historical introduction, at the end of which reference is made to the various designs of engines to receive consideration. Chapter II. contains a classification of Prime Movers, and proceeds to describe windmills and hydraulic machinery, water turbines, pulsometers, hydraulic cranes, steam jets, injectors, water jet propellers and centrifugal pumps. The section on windmills contains extracts from the 1903 report of the Royal Agricultural Society of Great Britain on the subject of wind engines, and some interesting particulars of the designs put forward in the competitive trials inaugurated by that body. The engines were intended for pumping purposes, and no reference is made to their value for driving dynamos. Mention is made of the chief features of windmills for this purpose in the opening lines of the chapter. One could have hoped for details of Continental experiments in this direction. The section on water turbines is very comprehensive, especially that dealing with turbine governors. The turbines described are all of small size, and no reference is made to the large machines now commonly used in large hydro-electric power plants. The units dealt with are interesting to users of water power in small amounts, but afford little or no information to the engineer interested in very large hydro-electric plants. The designs of Messrs. Gunther & Co., Oldham, predominate in the photo illustrations of water turbines.

Chapter III. is devoted to steam and gas turbines, with a section on the designing of the former. The subject of steam turbines is treated from its earliest stages to the early forms of the Curtis machine. A number of tests of turbines are included, but those of large machines date back to 1900, on the Elberfeld units, built by Messrs. Parsons. Of gas turbines little is or can be said. A patent of Mr. Ferranti's is described, but the absence of practical data naturally has prevented any enlargement on this none the less interesting subject.

The concluding chapter (IV.) is confined to rotary engines, and all that is to be said on these machines is compressed into 16 pages. Apart from its reference to well known designs, the work, in including in a volume descriptions of important prime movers, will doubtless prove of value. It bears the same stamp of staleness which marks all similar publications aiming at presenting information on technical subjects in condensed form, but this drawback it shares with kindred volumes, consequently, what would otherwise be detrimental is in reality beneficial. The omissions of quite modern apparatus are regarded as inevitable and the outcome of time required in preparation and printing, combined with an almost alarming rate at which developments now take place. We recommend the book to central station engineers, and shall look forward to the succeeding volumes with interest. Volume II. will contain particulars of internal combustion engines, hot air and blast furnace gas engines.

BOOKS RECEIVED.

The Indicator Handbook. C. N. Pickworth, Fallowfield. 3s. nett.

Table of Multiplication, Division, and Proportion. R. H. SMITH. A. Constable & Co., Ltd., Whitehall Gardens. 6s. nett.

O'Gorman's Motor Pocket Book. MERVYN O'GORMAN. A. Constable & Co., Ltd. 7s. 6d. nett.

Directory of Electric Lighting and Traction. Hazell, Watson & Viney, Ltd., 52 Long Acre, W.C. 10s. 6d. nett.

Electrical Engineering. SLINGO & BROOKER. Longmans, Green & Co., 39 Paternoster Row, E.C. 12s.

Necessary Practical Safeguards against Lightning. A. HANDS. J. W. Gray & Son, 115 Leadenhall Street, W.C.

Scientific Protection; a Guide to the Proper Application of Lightning Conductors. A. HANDS. J. W. Gray & Son, 115 Leadenhall Street, E.C.

The Motor-Man and his Duties. LUDWIG GUTMANN. Windsor and Kenfield Publishing Company, Byron House, Fleet Street, E.C. 4s. 6d.

Useful Engineers' Constants for the Slide Rule. J. A. BURNS. C. Conbridge, New Street, Birmingham. 9d. nett.

Introduction to the Study of Physical Chemistry. Sir W. RAMSAY, K.C.B., F.R.S. Longmans, Green & Co. 1s. nett.

Whittaker's Electrical Engineer's Pocket Book. 3s. 6d. nett.

The Phase Rule and its Applications. A. FINDLAY. Longmans. 5s.

Electric and Magnetic Circuits. E. H. CRAPPER. E. Arnold, 37 Bedford Street. 10s. 6d. nett.

Electricity and Magnetism. C. E. ASHFORD. E. Arnold, 37 Bedford Street. 3s. 6d.

Electrolytic Preparations. Dr. KARL ELBS. 4s. 6d. nett.

Modern Electric Practice. Vol. 2. Gresham Publishing Company. 9s.

Railway Year Book. Railway Publishing Company, 2s. 6d.

The Tariff Dictionary. Simpkin, Marshall, Hamilton, Kent & Co. 2s. 6d. (Blue Book abbreviated).

Reports of the Moseley Educational Commission. Co-operative Printing Society, Ltd., Tudor Street. E.C. 1s. 4d. post free. Free to Educational Authorities.

Radium and all about it. WHITTAKER. 1s. S. R. Bottone.

* * *

Contributions from the pens of the most eminent writers in the electrical profession, on subjects of great moment, will appear in the next and succeeding issues of "The Electrical Magazine." No one interested in the science or practice of electricity should loose the immediate opportunity of becoming a subscriber to a publication with so unique a claim upon the attention of electricians the world over. See announcements on the Tinted Supplement preceeding advertisements at the front of this issue.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whole will form an index guide of considerable importance and value.

Power.

Articles.

Electric Lighting in the City of Benjamin Franklin. W. C. L. Eglin.	*Elec. Wld. & Eng.* 5/3/04.
The Development of Alternating Work in America. C. A. Terry.	*Elec. Wld. & Eng.* 5/3/04.
*Wireless Power Transmission. N. Tesla.	*Elec. Wld. & Eng.* 5/3/04.
Expansion and Changes of Electric Light and Power Systems. A. D. Adams.	*Elec. Wld. & Eng.* 5/3/04.
Thawing Out Frozen Pipes Electrically. W. M. Petty.	*Elecy. N.Y.* 9/3/04.
Lightning Protection. G. Scott.	*Elecy. N.Y.* 9/3/04.
Electrical Installations in Isere Mines. G. Barbillion.	*L'Eclair Electr.* 12/3/04.
*Mining Installations of the Helios Co. E. Guarini.	*Elec. Rev. N.Y.* 12/3/04.
Schaffhausen Power Transmission.	*Elec. Wld. & Eng.* 12/3/04.
Electric Power in Bolivia Copper Mines. F. C. Perkins.	*L'Electr.* 19/3/04.
Gold Dredging. W. Clark	*Elec. Rev. N.Y.* 19/3/04.
The Zaneville Power Plant.	*Elec. Rev N.Y.* 19/3/04.
*Electricity in Agriculture. E. Guarini.	*La Rev. Tech.* 25/3/04.
The Leeds Tramways Power Station. E. J. Munby.	*Power.* Mar. /04.
West Ham Electricity Works.	*Electn.* 1/4/04.
Power Plant at Zwolfmalgreien, Austria. F. Koster.	*Elec Rev. N.Y.* 2/4/04.
Loft Buildings—Electric Power Desirable. E. R Knowles	*Elec. Rev. N.Y.* 2/4/04.
Transmission Plant at Elliott Falls, Ontario. C. L. Fitch.	*Elec. Wld. & Eng.* 2/4/04.
Power Plant of the New England Confectionery Co., Boston.	*Amer. Electn.* April /04.
*West Ham Electricity Works.	*Elec. Rev.* 8/4/04.
*Installations and Supply Areas of La Compagnie Est Lumière, Paris. P. Dupuy.	*L'Eclair Elect.* 9/4/04.
Some Electric Mining Installations. E. Guarini.	*L'Eclair Elect.* 9/4/04.

Papers before Societies.

Power Schemes—Projected and in Operation. W. B. Woodhouse and W. Emmott.	*Leeds I.E.E.* 24/3/04.
*The Adaptability of Electric Driving. R. Longbottom.	*Manch. Assoc. Engrs.* 26/3/04.
*The Architectural Design of Electricity Works. C. S. Peach.	*Royal Inst. Brit. Archts.* 28/3/04.
Electrical Winding in Germany. W. G. McMillan.	*N. Eng. Inst. Mining & Mech. Eng.* 9/4/04.

Traction and Transport.

Articles.

Foreign Mountain Electric Railways. F. C. Perkins.	*Elecy. N.Y.* 2/3/04.
Swiss Electric Railroading. F. Koster.	*Elec. Rev. N.Y.* 5/3/04.
Motor Output in Railway Service. W. Müller.	*Elek. Zeit.* 10/3/04.
The Operation of Points and Railway Signals by Power.	*Elec. Rev.* 11/3/04.
Through Booking and Conveyance of Passengers, Parcels, etc., on Tramways and Light Railways. T. Upton.	*Elec. Rev.* 11/3/04.
St. Georges de Couriers a da Mure Railway. P. Letheule.	*La. Rev. Electr.* 15/3/04.
Alternating Current Motors in Railway Operation. P. Huber.	*Elektrotechniker.* 15/3/04.
*Liverpool and Southport Railway Electrification.	*Engr.* 18/3/04.
High Speed Electric Locomotive of Siemens and Halske.	*L'Eclair Electr.* 19/3/04.
Sliding Bow *v.* Trolley. G. Hooghwinkel.	*Lt. Rly. & Try. Jrnl.* 1/4/04.
Metropolitan Electric Tramways, Ltd.	*Lt. Rly. & Try. Jrnl.* 1/4/04.

Papers.

The Management of the Bradford City Tramways. C. J. Spencer.	*Bradford Sci. Assoc.* 18/3/04.
London Streets and London Street Traffic. T. Blashill.	*Sanitary Inst.* 18/4/04.

Lighting and Heating.

Articles.

Electric Arcs and their Uses. (Ccld. 15/3/04.) J. Bing.	*Elek. Runds.* 1/3/04
*The Beginnings of the Incandescent Lamp. T. A. Edison.	*Elec. Wld. & Eng.* 5/3/04.
*A Quarter Century of Electric Lighting. L. Bell.	*Elec. Wld. & Eng.* 5/3/04.
*Fifteen Years of Electric Heating. J. T. Ayer.	*Elec. Wld. & Eng.* 5/3/04.
Series A.C. Enclosed Arc Lighting in Union Stock Yards	*Westn. Elec.* 12/3/04.

*Electricity and Anemometry in the Sea Coast Artillery Service. M. C. Sullivan.	*Elec. Rev. N.Y.* 19/3/04.
*On the Photo-Electric Properties of Selenium. A. Berthier.	*L'Eclair Electr.* 19/3/04.
Metal Conduits for Electric Light Installations. L. M. Waterhouse.	*Elec. Rev.* 1/4/04.
Regulating the Resistance of Mercury Vapour Lamps. A. Bainville.	*L'Electr.* 2/4/04.
Electricity on Steamships. E. W. Percy.	*Amer. Electn.* April, /04.

Papers.

The Hewitt Mercury Vapour Lamp. Magnus Maclean.	*Inst. Eng. & Shpblds. Scotland.* 22/3/04.

Telegraphy and Telephony.

Articles.

A Cord Testing Set for Magneto Systems. C. Bundesman.	*Amer. Tel. Jrnl.* 5/3/04.
The Progress of Telegraphy during the last 30 Years. W. Maver.	*Elec. Wld. & Eng.* 5/3/04.
*25 Years of Telephony. A. V. Abbott.	*Elec. Wld. & Eng.* 5/3/04.
Rapid Type-printing Telegraph. W. v. Siemens.	*Elek. Zeit.* 10/3/04.
Wireless Telegraphy (III.). R. G. Blaine. (IV.—25/3/04.)	*Elec. Eng.* 11/3/04.
*The Actual State of Wireless Telegraphy. G. Ferrie.	*L'Eclair. Electr.* 12/3/04.
Telephone Transmitters. Serial (VII). A. V. Abbott.	*Elec. Wld. & Eng.* 12/3/04.
*Methods of Operating and Signalling in Telephone Exchanges. K. R. Miller and C. S. Wrieston. (Concld. 26/3/04.)	*Elec. Wld. & Eng.* 12/3/04.
Bridged Multiple Troubles. A. O. Stigberg.	*Amer. Teleb. Jrnl.* 12/3/04.
Operation of Small Telephone Exchanges. H. S. Knowlton.	*Westn. Elec.* 12/3/04.
Modern Submarine Telephonic Cables. F. Breisig.	*Elek. Zeit.* 17/3/04.
Municipal Telephony (IV.).	*Elec. Eng.* 18/3/04.
*A Novel Switchboard Cleaner. J. E. Peavey.	*Amer. Telep. Jrnl.* 19/3/04.
*Impedance and Retardation (III.) A. V. Abbott.	*Amer. Telep. Jrnl.* 19/3/04.
Present Independent Telephone Situation. J. B. Ware.	*Electy. N.Y.* 23/3/04.
Teletyping Service in Berlin. A. Francke.	*Elek. Zeit.* 24/3/04.
The Hollywood Exchange, California. P. K. Higgins.	*Amer. Telep. Jrnl.* 26/3/04.
An Automatic Pole Changer Starter. C. S. Bundesmann.	*Amer. Telep. Jrnl.* 26/3/04.
Wireless Telegraphy (Contd.). R. G. Blaine.	*Elec. Eng.* 1/4/04.
Localization of Faults in Submarine Cables.	*Elec. Rev.* 1/4/04.
Electric Timing Arrangements on the "Cresta" at St. Moritz.	*Elec. Rev.* 1/4/04.
Street Corner Telephones. C. A. Long.	*Amer. Telep. Jrnl.* 2/4/04.
*Telephone Exchange Engineering. (XVI. Serial) R. H. Manson, A. D. T. Libby, and C. A. Simpson.	*Amer. Telep. Jrnl.* 2/4/04.
Circuits and Operation of a Common Battery Branch Exchange. H. Sproul.	*Amer. Telep. Jrnl.* 2/4/04.
*Simultaneous Telegraph and Telephone Equipment. R. W. Stanton.	*Elec. Wld. & Eng.* 2/4/04.
The Telephone Sub-station. (II) A. V. Abbott. (I.—26/3/04)	*Elec. Wld. & Eng.* 2/4/04.
Resonance Induction Coils and their Use in Wireless Telegraphy. Dr. G. Seibt.	*Elek. Zeit.* 7/4/04.
*Telegraphic Transmission of Photographs, Drawings. H. J. Reiff.	*Elek. Anzr.* 7/4/04.
Manual *v.* Automatic Telephone Exchanges. H. S. Knowlton.	*Amer. Electn.* April, /04.
Telephone Engineering, Cable Terminals. F. J. Dommerque.	*Amer. Electn.* April, /04.
The Maintenance of Common Battery Central Offices. A. D. O'Brien.	*Amer. Electn.* April, /04.
Minor Wireless Telegraphy Progress, 1903. J. B. Baker.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.

Papers.

A Telephone Plant as a Side Line. J. C. Thorne.	*Iowa Telep. Conv.* 9/3/04.
The Necessity of Uniformity in Toll Line Service and Rates. D. M. Griswold.	*Iowa. Telep. Conv.* 9/3/04.
*Corporation Telephones. A. R. Bennett.	*Glasgow Inst.E.E.* 12/4/04.

Electro-Chemistry.

Articles.

The Development of Industrial Electro-Chemistry. E. F. Roeber.	*Elec. Wld. & Eng.* 5/3/04.

Papers.

Notes on the Industrial Electrolysis of Water. W. S. Landis.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
A New Primary Battery. E. G. P. Bousfield.	*Faraday Soc.* 13/4/04.

Electro-Physics.

Articles.

Circular Diagram of Induction Motors above Synchronism. Müller.	*Elek. Zeit.* 3/3/04.
Connection between Luminous Intensity and Temperature. H. Fisler.	*Elek. Zeit.* 10/3/04.
Immediate Observation of Distribution of Tension and Method of Rendering Visible the Neutral Layer with Bodies put to an Elastic Strain. O. Hönigsberg.	*Zeits. Oester. Ingen.* 11/3/04.
*Petrus Peregrinus: Author of the Earliest Treatise on the Magnet, 1269. Brother Potarnian.	*Elec. Wld. & Eng.* 12/3/04.
Diagrams for Compensated Series Motor. M. Osnos.	*Elek. Zeit.* 17/3/04.
Inflammability of Flexible Rubber Strings and their Ignition through Electrical Currents. J. Herzog and C. Feldmann.	*Elek. Zeit.* 17/3/04.
*Producing High Frequency Currents and Some of their Phenomena. E. P. Northrup and E. Woods.	*Elec. Rev. N.Y.* 19/3/04.
The N Rays. J. B. Whitehead.	*Elec. Rev. N.Y.* 19/3/04.
Experiments with X Rays and Radium. E. P. Thomson.	*Elec. Wld. & Eng.* 19/3/04.
Thermo-electric Forces in Heated Wire. F. Schneider.	*Elek. Zeit.* 24/3/04
Use of Condenser with Alternating Current Measurements. Prof. W. Peukert.	*Elek. Zeit.* 24/3/04.
A Phase Meter. Prof. A. Grau.	*Elek. Zeit.* 31/3/04.
Producing Pure Sinoidal Currents. R. Rüdenberg.	*Elek. Zeit.* 31/3/04.
*A *Resumé* of our Knowledge of the Physical Properties of Current Bearing Matter. Dr. P. R. Heyl.	*Elec. Rev. N.Y.* 2/4/04.
*The Shielded Balance. G. A. Campbell.	*Elec. Wld. & Eng.* 2/4/04.
Distorted Alternating and Rotating Magnetic Fields. R. Goldschmidt.	*Elec. Rev.* 8/4/04.

*Predetermining Solenoid Characteristics. W. A. Del Mar.	*Amer. Electn.* April /04.

Papers.

Magnetic Decomposition of Radium Lines. Profs. C. Runge and J. Precht.	*Berlin Acad. Sci.* 18/2/04.
Disruptive Discharge at Very High Tension. J. de Kowalski.	*Acad. des Scs.* 22/2/04.
The Conductivity of the Atmosphere at High Voltages. H. J. Ryan.	*Amer. I.E.E.* 26/2/04.
Further Experiments on Luminous Phenomena produced by Ozone and Radium. Prof. F. Richarz and Dr. R. Schenck.	*Berlin Acad. Sci.* 3/3/04.
Conductivity of Solutions of Radium Bromide. F. Kohlrausch and F. Henning.	*German Phys. Soc.* 4/3/04.
Radio-Activity of Certain Minerals and Mineral Waters. R. J. Strutt.	*Royal Soc.* 10/3/04.
The Measurement of Small Inductances, etc. J. A. Fleming.	*Phys. Soc.* 25/3/04.
A Hot Wire Ammeter for Small Alternating Currents. J. A. Fleming.	*Phys. Soc.* 25/3/04.
The Energy of Secondary Rontgen Radiation. C. G. Barkla.	*Phys. Soc.* 25/3/04.
Exhibition Evening.	*Röntgen Soc.* 7/4/04.
The Energy of Ions. L. A. Parsons.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
*Eddy Currents and Eddy Current Losses in Cable Sheaths. M. B. Field.	*Inst. E.E.* 14/4/04.

Electro-Metallurgy.

Articles.

*The New Swedish Electric Furnace Plant for Manufacture of Steel. F. C. Perkins.	*Elecy. N.Y.* 16/3/04.

Papers.

The Electrolytic Analysis of Gold. F. M. Perkin and W. C. Prebble.	*Faraday Soc.* 21/3/04.
Thin Film Electrolysis with an Application to Printing. C. R. Darling.	*Faraday Soc.* 21/3/04.
*The Electrical Manufacture of Steel. G. Gin.	*Elec. Chem. & Metall.* Mar. /04.
The Electro-deposition of Cadmium and its Alloys. S. Cowper-Coles.	*Elec. Chem. & Metall.* Mar. /04.
Electric Smelting Experiments for Manufacture of Ferronickel from Pyrrhotite. E. A. Syostedt.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
New Electrolytic Separation of Gold and Silver. H. Poole.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
The Economic Balance in Electrolytic Copper Refining. L. Addicks.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
The Preparation of Electrolytic White Lead. C. F. Carrier.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.
Electrolytic Iron. C. F. Burgess and C. Harnbeuchen.	*Amer. Elec. Chem. Soc.* 7, 8, 9/4/04.

Students.

Articles.

Requirements of Modern Engineering Practice in the Education of Electricians. (Contd. 24/3/04; concld 27/3/04.) C. Feldmann.	*Elek. Anzr.* 20/3/04.
The Laboratoire Central d'Electricité, Paris. A. Campbell.	*Elec. Rev.* 25/3/04.
*The Augustus Lowell Laboratories of Electrical Engineering.	*Elec. Rev. N.Y.* 26/3/04.
Polyphase Electrical Machinery (Serial). A. Stewart.	*Electy.* 1/4/04.

Papers.

Testing of Continuous Current Machinery. L. A. Lewes.	*Inst. E.E. (Stdnts.)* 16/3/04.
Photometric Testing. D. L. Sands.	*Manch. Inst. E.E. (Stdnts.)* 25/3/04.
Relative Advantages of Continuous and Alternating Currents for Traction Purposes. J. M. Kennedy.	*Inst. C.E. (Stdnts.)* 25/3/04.
Direct Current Controllers. H. N. Dutton.	*Manch. I.E.E. (Stdnts.)* 8/4/04.

Manufacturers.

Articles.

High Voltage Direct Current Dynamo.	*Zeit. F. Elek.* 6/3/04.
Single and Three-Phase Meters. Siemens & Halske.	*L'Ind. Electr.* 10/3/04.
Design of Choking Coils for A. C. Circuits.	*Elec. Eng.* 11/3/04.
Types of L. T. Direct Current Switchgears (I.). (II., 8/4/04.) W. E. Warrilow.	*Elec. Eng.* 11/3/04.
Calculation of Motor Starting Rheostats. F. Meurer and A. Simon.	*Elec. Wld. & Eng.* 12/3/04.
The Design of Motor Starting Rheostats. M. Treimark.	*Elec. Wld. & Eng.* 12/3/04.
Predetermination of Transformer Regulation. E. G. Reed.	*Elec. Wld. & Eng.* 12/3/04.
Theory and Calculation of Electrical Continuous Current Machinery. A. Ekström.	*Tek. Tids.* 12/3/04.
*Calculation of the Equivalent Ampère Turns of Windings for Single and Polyphase Currents (III.) C. F. Guilbert. (Concld. 26/3/04.)	*Elec. Wld. & Eng.* 12/3/04.
Design and Manufacture of High Tension Cables. (IV. Concld. 17/3/04.) J. Schmidt.	*Elek. Anzr.* 13/3/04.
Simple Calculations of Rotary Current Motors. H. M. Hobart.	*Zeit. für Elek.* 13/3/04.
*On Turbo Dynamos. F. Neithammer.	*Elec. Wld. & Eng.* 19/3/04.
*Single-phase Commutator Motors. Prof. J. K. Sumec.	*Zeit. für Elek.* 20/3/04.
Variable Speed Motors. J. W. Burleigh.	*Elec. Rev.* 25/3/04.
Distortion and Dispersion in Alternators. C. F. Guilbert.	*La Rev. Tech.* 25/3/04.
*The "Dialt" Motor. N. H. Edgerton.	*Elec. Wld. & Eng.* 26/3/04.
*On Turbo-Dynamos (II.). F. Neithammer.	*Elec. Wld. & Eng.* 26/3/04.
Calculation and Practical Formula for Rotary Current Motors. E. Schulz.	*Elek. Anzr.* 31/3/04.
Efficiency Test of 1,250 K.W. Steam Turbine. A. M. Mattice.	*Power.* Mar. /04.
A Useful Device for Baking Armature Coils. F. B. O'Hanlon.	*Amer. Electn.* April /04.
Electric Wiring of Machine Tools. O. W. Bodler.	*Rly. Master Mech. N.Y.* April /04.
*Variable Speed Motors. W. Baxter, Junr.	*Machinery, N.Y.* April /04.

Papers.

High Speed Engines. A. B. Crawford.	*Assoc. Eng. in charge.* 10/3/04.
*Notes on the Design of Electrical Machinery. J. L. Hunt.	*Liverpool Eng. Soc.* 23/3/04.
*Steam Turbine Propulsion for Marine Purposes. A. Rateau.	*Inst. Naval Archts.* 25/3/04.

Central Station Practice.

Articles.

Eliminating the Influence of the Power Factor on the Work done by Steam Engines in Electric Stations, by the use of Wattless Current Alternators. Prof A. Woronoff.	*Elektritschestvo.* Feb. /04.

Pulsations of the Direct Current of Synchronous Convertors. Elsaesser.	*Elec. Zeit.* 3/3/04.
Alternating Current Machines Connected in Parallel. J. G. Köhler.	*Elek. Anzr.* 6/3/04.
The Choice of Wattmeters. H. P. Davies.	*Elec. Wld. & Eng.* 12/3/04.
Earth Connections. W. Moon. (Concld. 25/3/04).	*Elec. Rev.* 18/3/04.
Standardizing Subway Manhole Construction. H. C. Baker, junr.	*Elec. Wld. & Eng* 19/3/04.
Indicator Diagrams from Steam Turbines. W. H. Booth.	*Elec. Rev.* 25/3/04.
Economy in Electric Mains. B. C. H. J.	*Elec. Eng.* 1/4/04.
The Economy of Reciprocating Engines at Light Loads Compared with that of Steam Turbines. J. A. Seymour.	*Elec. Wld. & Eng.* 2/4/04.
Engine Valves and Valve Gears. C. C. Major.	*Amer. Electn.* April, /04.
*The Steam Turbine in Power House Extensions.	*Amer. Electn.* April, /04.
Cleaning Boiler Surfaces. R. T. Strohm.	*Amer. Electn.* April, /04.

Papers.

The Installation of Electric Cables. H. W. Buck.	*Electric Club.* 29/2/04.
Three Wire System.	*West Hartlepool Coll. Sci. Soc.* 12/3/04.
Localization of Faults on L. T. Networks. W. E. Groves.	*Brhm. I.E.E.* 16/3/04.
Direct Reading Instruments for Switchboard Use. K. Edgcumbe and F. Punga.	*Inst. E.E.* 24/3/04.
Electric Meters. G. W. Carson.	*Iowa Elec. Assoc.* 13-14/4/04.
Combustion of Iowa Fuel. G. W. Bissell.	*Iowa Elec Assoc.* 13-14/4/04.
Incandescent Lamp Tests. Prof. Spinner.	*Iowa Elec. Assoc.* 13-14/4/04.
Station Steam Piping. C. C. Gartland.	*Iowa Elec. Assoc.* 13-14/4/04.

Electrical Work in Shops.

Articles.

Construction of 2 h.p. Motor or 25 light Dynamo. F. C. Mason.	*Amer. Electn.* April, /04.
Hints for Wiremen. E. E. Warner.	*Amer. Electn.* April, /04.

Trade and Commerce.

Papers.

The Opportunites in the Electrical Business. G. A. Damon.	*Western Soc. Engrs. Chicago.* 18/3/04.

Finance and Legislation.

Articles.

Electric Lighting Companies and their Statutory Powers. J. E. R. Stephens.	*Public Health Engr.* 2/3/04.
*Electricity and the Law in England and America. W. V. Ball.	*Elec. Wld. & Eng.* 2/4/04.

Papers.

Station Accounting. R. Ferris.	*Iowa Elec. Assoc.* 13-14/4/04.

* * *

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, ***with names and addresses of manufacturers, will be given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.***

* * *

Power.

Motors and Motor Applications. R. Waygood & Co., Falmouth Rd., E.C., have issued a neat *brochure* on their electric service lifts, a copy of which is before us. The lifts are of the push button class, and designed for hotels, restaurants, clubs, schools, etc. From the description given, the lifts are artistically arranged, while the electrical gear is compact and easily controlled. The same firm issues a list of passenger and goods lifts which can be had on application.

The Electrical Mining Co., Ltd., 9 Iron Gate, Derby, are a firm, as their name implies, having interests in the application of electric power in mines. A glance through their 40 page catalogue will give an excellent idea of the field of operations covered by their specialities, which range from the generating plant complete to a magneto exploder. Mining managers would do well to secure a copy of this interesting booklet.

The General Electric Co., Queen Victoria St., E.C. "Witton" small motors are described and priced in an eight page catalogue recently issued by the G.E. Co.

The Yorkshire Electric Power Co., Central Bank Chambers, Infirmary St., Leeds. This enterprising company has favoured us with Nos. 1 and 2 of its *brochures*. Each of these sets out in a popular form the uses of electric power, setting forth its advantages, and particularising the motors extensively adopted. The efficiencies of various motors are compared. The scale of charges adopted by the company is also set out. There is very little reason why prospective consumers of electric power should long remain in ignorance as to its advantages and availability.

The Crypto Works Co., Ltd., 29 Clerkenwell Rd., E.C. A neat catalogue describes the specialities of this firm in the shape of small motors, charging dynamos, motor generators, transformers, and instruments. A feature of the catalogue is the Crypto petrol dynamo.

Griffith & Biliotti, 8 John St., Adelphi, Strand, W.C. The polyphase induction motors, type S.C., manufactured by this firm, are described in a four page pamphlet.

The Lahmeyer Electrical Co., Ltd., 109-111 New Oxford St., W.C. Controllers and apparatus for cranes, hoists, lifts, etc., form the subject of a substantial catalogue issued by this firm. Full prices and particulars are given, together with a number of interesting illustrations.

Pott, Cassels & Williamson, Centrifugal Machine Specialists, Motherwell, Scotland. Some practical notes on the driving of centrifugal machines by belt, water, and electricity are contained in an interesting catalogue. A section of an electrical centrifugal is given, together with an efficiency diagram of a 48 in. type.

Bergmann Electrical Works, 6 Victoria Avenue, Bishopsgate St. Without, E.C., have supplied us with a full list of their catalogues. These deal respectively with direct current motors, lift controllers, magnetic brakes, motor starters, tandem motors and control, lever switches, three-phase motors, and accessories.

Traction & Transport.

Batteries. The N.S. Electric Storage Co., Ltd., Horton Kirby, Kent, makers of the N.S. semi-solid and portable batteries, describe their specialities in several interesting leaflets. Details of the N.S. cell were given in our Manufacturers section last month.

Electric Battery Co., 180 High Holborn, W.C., issue an illustrated catalogue detailing and pricing their specialities in batteries for ignition purposes, coils, sparking plugs, etc. We referred to these in our description of the recent Crystal Palace show last month.

The A.B.C. ACCUMULATOR Co., Ltd., Parkfield, Stockton-on-Tees, are makers of secondary cells for all classes of work. Their elements are made up of a Planté positive and a pasted negative plates, and all sets are assembled complete for dropping into the glass boxes before delivery. The plates hang down from the top edge of the containing case. The price list before us contains full details and prices of all the firm's specialities in this direction.

R. W. VICAREY & Co., 101 Peel Terrace, Marston Road, Stafford, have sent us a booklet entitled, "Why do Storage Batteries Fail?" According to the argument put forward, the treatment of the electrolyte is among the chief causes of failures, and, as expert analysts, the firm will put matters right if samples of the solution are submitted them. Battery attendants are not generally particular what liquid goes into a cell; consequently, the presence of an authority, whose judgment can be relied upon, should be welcome to all battery users, to whom we recommend the booklet.

Rail Joints & Signals. Estler Bros., 25 Laurence Poulteney Lane, Cannon St., E.C., have issued an 8 page booklet describing the Imperial rail joint which is intended to supercede the regular fish plate for railways, and especially electric roads, where undue jarring is apt to loosen the conductor joints.

The same firm has sent us a leaflet describing Harvey's Patent Automatic Electric Tramway Signal. This is operated electrically by the car trolley wheel, which closes a circuit through a solenoid, and raises the semaphore to danger, subsequently releasing it after passing a certain contact. The device is for use of tramways to inform drivers if a car ahead has left a section.

Runways. THE C. W. HUNT Co., West New Brighton, Staten Island, N.Y. Particulars of an electric storage battery locomotive have been supplied us by this firm. We shall hope to comment further on this interesting locomotive at some future date From the same source we have received a catalogue entitled, "Industrial Railways," dealing with the narrow gauge tracks and rolling stock, which have been Messrs. Hunt's speciality for some time.

Locomotives. THE BRUSH ELECTRICAL ENGINEERING CO., LTD., Loughborough, Leicestershire. Bulletin No. 5, recently mailed to us, contains details of steam and electric locomotives. We publish in our Manufacturers' section this month some particulars of the latter, which will be found on page 414.

Lighting and Heating.

Conduits. THE SIMPLEX STEEL CONDUIT CO., LTD., 80 Digbeth, Birmingham. A handsome show card, setting out in relief and on a large scale the registered trade mark of the company.

Fittings. C. J. THURSFIELD & Co., Cecil Works, Clement St., Parade, Birmingham. An artistically arranged catalogues, gives details and prices of the electric light fittings which are the speciality of this firm. A number of very pretty pendants, electroliers, lanterns, and brackets are depicted, and the designs speak very highly for the thought and care which has evidently been bestowed upon them.

Lamps. THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., Ediswan Buildings, Queen St., E.C. A two page leaflet describes the "Ediswan" improved radiator lamps.

Arc Lamps. The Davis Electric Lamp Co., 17 Moor St., Cambridge Circus, W. The "Arcazon" long-burning arc lamp of this firm is fully described in a 4 page leaflet. The makers claim several unique features: simplicity of construction, whiteness of light, and compactness. For the last, the lamp is only 26 in. long, and a single pair of carbons will burn 100 hours. The leaflet gives detailed prices.

Accessories. THE CONSOLIDATED ELECTRICAL CO., LTD., Northampton Grove, Canonbury, N. A sixty-four page catalogue has been handed to us by this firm, and it represents Section A among the lists which they publish. It deals with central station switchboards, distributing fuse boards, main switch fuses, and lightning arresters. House service cut-outs are also described. The same firm issue, in addition, Sections B, dealing with electric light accessories; C, circuit breakers and instruments; D, telephones and bells.

DORMAN & SMITH, Ordsal Electrical Works, Salford, Manchester. A number of leaflets issued by this firm have been added to our list. These deal chiefly with such accessories as ships' fittings, wall plugs, distribution boxes for specially damp position, and D. & S. "Grip" contact circuit breakers are also described.

Telegraphy and Telephony.

Bells. THE GENERAL ELECTRIC CO., LTD., Queen Victoria St., E.C. The G.E. Co. have issued their new catalogue, Section L., dealing with electric bells. This is a most comprehensive edition.

Forthcoming Events

A complete list of the meetings of various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, will be listed under order of date in this section.

◆

Exhibitions.

Universal Exposition, St. Louis, U.S.A.
April 30th to December 1st, 1904.

Bradford Industrial Exhibition.
May 4th, 1904.

Electrical Exhibition, Warsaw.
May to September, 1904. } This has now been postponed.

Colliery Exhibition, Royal Agricultural Hall, London.
June 25th to July 2nd, 1904.

Third International Congress of Mathematicians, Heidelberg.
August 8th to 13th, 1904.

Exposition Internationale au Grand Palais, Paris.
August to November, 1904.

Industrial Exhibition, Cape Town.
November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

THE date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition. The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

Papers before Societies.

Royal Institution.

Prof. Ernest Rutherford, M.A., D.Sc., F.R.S., on "The Radiation and Emanation of Radium." *May 20th, 1904.*

His Serene Highness Albert Prince of Monaco, on "The Progress of Oceanography." *May 27th, 1904.*

Prof. Svante Arrhemus, of Copenhagen, Hon. Mem.R.I., Hon. F.C S., on "The Development of the Theory of Electrolytic Dissociation." *June 3rd, 1904.*

The lecture arrangements include three lectures (5 p.m.) on "Dissociation," by Prof. Dewar (Fullerian Professor of Chemistry, R.I.), on *April 14th, 21st, and 28th, 1904.*

Institution of Electrical Engineers.

C. H. Merz, on "Power Station Design, I." *April 28th 1904.*

Meetings, Conventions, etc.

German Society of Electro Chemists.

Annual Meeting, *May 12th—14th, 1904.*

Association of Municipal Engineers.

Meetings at Grimsby, *April 23rd*; Newcastle, *May 6th* and *7th*; York, *May 14th*; Buxton, *May, 20th and 21st, 1904.*

National Electric Light Association.

27th Annual Convention, Boston. *May, 1904.*

Books.

Dynamo, Motor and Switchboard Circuits.

Crosby Lockwood & Son.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

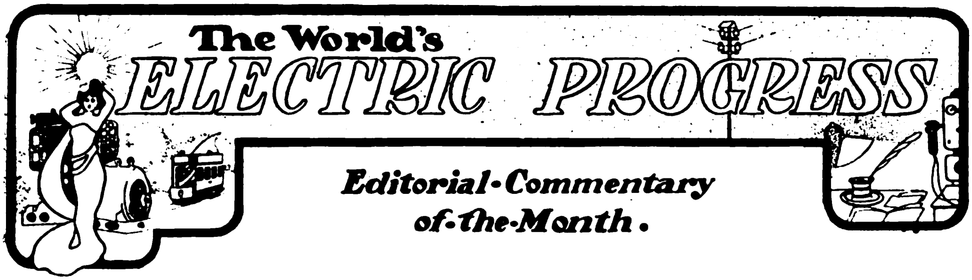
No. 5. Vol. I. London. May 26, 1904.

POWER STATIONS.

In the case of Power Supply, Reliability of Supply must take precedence over everything else, even over Economy of Production. This factor in Power Station Design was clearly enunciated in Messrs. Merz & McLellan's recent paper, "Power Station Design," read before the Institution of Electrical Engineers. Probably no paper presented to that body this session has excited so much discussion or called forth such favourable comment. The opinions of the authors, based as they are on actual experience of the problems presented in designing large power plants, deserve careful perusal by electrical engineers and especially those consultants now responsible for many important schemes having Parliamentary sanction, and shortly to start supply on a large scale. Compared with the sentiments of electrical men voiced through similar channels in the early days of the industry, there are striking differences between the principles pronounced so decidedly in the present *dictum*. *Then* the chief object in view was the erection of a suitable station, in which the best plant obtainable at the time was installed, when engineers took sides upon high and slow speed engines and when the engineering features of the station were predominant over all else about it. Engineers had the whip hand in those days, and though avowedly installing economical plant they designed the station primarily on prevalent lines, with no special thought for reliability of supply. At any rate, if the desire to avoid mishap was present, it was not expressed in the apparatus installed. *Now*, as the opening sentence clearly indicates, reliability of supply must take first place, and in the paper under consideration two principles are put forward as tending to accomplish this end, namely, simplicity of design and sub-division of plant and apparatus. These we take for consideration apart from two other principles—labour saving devices and provision for extension—having economy of production as their object. Under simplicity of design, the entire plant, from stoke hole to feeder terminals is criticised, but it is chiefly in the engine room where these criticisms are most felt. From a crucial experience and from the very home of the machine itself, the complete plump for steam turbines by the authors of the paper, is not suprising. The points of difference between this new development of an old idea and the reciprocating engine, are too well known to need reiteration on our part. Apart from the simplicity of apparatus conveyed by turbines, their adoption "materially reduces the capital cost of a power station. This reduction amounts to from 15 per cent. to 20 per cent. over the whole station, even on present market prices, and it will be much greater when the manufacture of turbines has become as completely standardised as that of reciprocating engines." In the employment of steam turbines, however, the combined efficiency of boiler and engine is raised but little, if any, above the present standard, consequently the hopes of central station engineers are centred in the gas engine as the *beau ideal* of a prime mover for driving a dynamo. Of the future of gas plant there can be little doubt, but ere large units can be made to economically replace reciprocating and turbine engines, the development of the latter can be reasonably assumed to have reached a degree of perfection at present barely approached. If this be the case, engineers can hardly be expected to abandon so simple and reliable a prime mover as the steam turbine for an engine, which though doubtless economical beyond the best the turbine can do, will be a mass of heavy moving parts and will spread itself over a floor area quite out of proportion to its output. The enthusiasm at present evinced by large firms in producing and installing reliable steam turbines can have but one result, the employment of such engines in all large stations to the exclusion of reciprocating sets of every description. With this prospect in view, the makers of gas plant would do well to consider the suitability of their slow speed clumsy engines for supplanting the neat, compact, high speed turbo-set whose chief claim to prominence has been simplicity of design. If continuous combustion can be arrived at and a gas turbine produced, the hopes of engineers may come near fulfilment, but the return to heavy complicated machines, after perhaps years of experience with a prime mover delightful in comparison, does not bear contemplation. Who knows but that the reciprocating steam engine may have fallen into disuse at the time when the gas engine is sufficiently reliable to oust the steam turbine? Again, the standardisation of the design of power stations may be looked for when turbine manufacture has settled itself, and this circumstance will be attended with economy of floor space of the generating units. Moreover, the construction of turbo dynamos would assume a definite level compatible with the speeds of turbines. With the revival of the gas engine, the old difficulties attendant upon having heavy reciprocating parts in large engines would be presented and the old story of unreliability, uncertainty and even danger, so often told with monster steam sets would be told again with the gas engine. The matter is none the less complicated if high speeds be chosen, as limits, compelling the compromise of slow speed, are ultimately reached and additional complication encountered. If we are to have the gas engine at all, there seems nothing for it but to produce it in a rotary form. It can then slip into the gap which steam turbines cannot fill, without necessitating a return to methods and principles which must ultimately seem barbaric in comparison with those directly resulting from previous experience. The prospect we present may not appear admissible by all the present circumstances, but a close examination of the facts seems to bring this view broadly before us.

Concerning the sub-division of plant, the increase both in size and number of the units now common, compels attention to a detail at one time unimportant, but now a vital factor for the consideration of the power station designer. The running of the plant in isolated units or combinations of units, cannot but commend itself to engineers, and when reliability of supply is the object in view such an arrangement is essential to the attainment of that object. At one time the sub-division did not extend beyond the switchboard, where isolating switches were provided for sectionising the electrical units, but only in respect to the energy produced. It is only in recent years and since stations have been built on a large scale in America, that the plant installed has been treated as so many independent stations, comprising boilers, engines, and switchgear of a certain output, provision for inter-connection being sometimes made. The operation of the station on this plan may ultimately lead to the entire sub-division of the whole supply system. This would, of course, be nothing new, as, in the earliest alternate current plants, the generators were run on separate circuits.

Space will not permit us to enter more fully into the questions raised above, nor upon many others touched upon by the authors, but we heartily commend their excellent paper to the notice of our readers, as saying what is wanted and saying it well, on a subject having such vital consequences to the electrical industry.



The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month.

* * *

This section consists of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They are mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

* * *

St. Louis Exposition.

In this issue we continue our remarks on the electricity exhibits at the St. Louis Exposition just opened. The magnificent scale on which the Palace of Electricity has been planned, and the care and thought expended on the arrangement of the exhibits from an educational standpoint, should impress all visitors. To popularise electricity is to stimulate the industry dealing with it, and if the object of the promoters is realised, much benefit will accrue to the profession both in America and the world over, for will not the exhibition be the universal attraction this year?

* * *

Electricity in Steel Works.

Mr. P. R. Allen's articles on the use of electricity in mining and metallurgy will be brought to a conclusion next month. The last chapter will form a fitting termination to an attractive series, and will contain information and illustrations hitherto unpublished in English. We are the first journal to emphasise the importance of electrically operating both mining and steel works machinery in a series of illustrated articles, even though credit be taken elsewhere for the discovery of such machinery on the Continent.

* * *

Electrolytic Iron.

The recent annual convention of the American Electrochemical Society was, we understand, poorly attended, but productive of some valuable results. Prof. C. F. Burgess, of Wisconsin University, announced his success with the developments of a process for making electrolytic iron. The iron is produced at the rate of 2·2 lbs. per kilowatt-hour or at a cost of ½ cent per lb., the purity of this product being 99.9 per cent., the only impurity being hydrogen. With these figures we may look for some interesting developments in the future.

* * *

Polyphase Armature Windings.

The article on the "Windings of Alternator Armatures"—written by Mr. A. C. Eborall, and published in this issue—will be found exceptionally valuable and interesting to users and manufacturers of such machines. We may remark here that attempts have been made to combine the advantages of the hole winding with those of the former wound coils by the adoption of a design of an intermediate character. This takes the form of a hand made coil, made upon a former in seamless insulating tubes, one side of the coil being left open, that is, each conductor being left with long ends projecting straight out of the tubes. The completed coil is thus of the nature of a rectangle with one (short) side missing, and it can in consequence be slipped into its slots from one side. As this implies the connecting up of all the conductors forming the coil afterwards, there being consequently a joint in every turn, it is very difficult to make a good and neat job of the winding. and the presence of so many joints will add to the risk of breakdown. It is hardly likely therefore that such a design will ever come into favour in this country, where the standard of quality in these matters now stands so high.

* * *

What Next!

THE following, from an American newspaper and culled from *The Western Electrician*, is worth reproducing. "How to harness the static electricity floating about the summit of Pike's Peak and to divert the now wasted energy to the operation of the cog road up the mountain, is the problem upon which engineers are now at work. From recent experiments, it is believed that the electricity can be transferred to the base of the peak, and there stored in such quantities that the road can do away with steam power. If this problem is solved successfully and the change made, one of the greatest electrical engineering feats in history will have been accomplished, and Colorado will be its birthplace." The last sentence, as our contemporary remarks, fairly bristles with truth.

* * *

Continuous v. Single-Phase Traction Motors.

MR. H. M. HOBART discusses this question in *The Electrical Review*, of April 29 and May 6. While giving full weight to the important advance made by the recent evolution of practicable single-phase commutator motors, the author points out that, at any rate in its present stage of development, the latter is considerably less efficient than the former. Mr. Lincoln's paper, referred to in our February issue, page 165, is criticised in detail, and it is contended that this writer has overlooked a number of points which would tend to increase the cost of the single-phase system which he takes as an example. Mr. Hobart then takes Mr. Lincoln's 60-mile interurban road, and compares the figures given by the latter for a single-phase equipment with a continuous current equipment operated at a voltage of 1,350 from two stations situated at a distance of 15 miles from each end of the line, and 30 miles from each other.

The comparison is worked out in detail, and the conclusion arrived at is that the continuous current system will show an advantage of 30 per cent. in first cost, and of 7 per cent. in total yearly operating expenses for power and maintenance of electrical plant.

* * *

Electricity in the Liaotung Peninsula.

AT the present moment, when the eyes of the world are centred on the Far East, it may be of interest to note that the town of Dalny, near Port Arthur, is one of the most progressive communities in the East, as concerns the application of electricity to public and private requirements. The central station has a total capacity of 3,000 h.p., and affords space for additional plant of equal output. In addition to public and private lighting, electricity is applied for the provision of power for pumping dry docks, and for driving the machine, boiler, and other workshops in connection with the harbour. The town also possesses an admirable telephone system, and is an excellent example of electric progress inaugurated by a nation not generally recognised as pioneers in the adoption of modern methods and practice. (If recent reports are correct the town has been destroyed.)

* * *

British and German Wages.

A CURIOUS incident has arisen out of the tenders recently invited by the Glasgow Corporation for six motor-generator sets. Being left finally with two tenders for consideration—one of the British Westinghouse Company, for £11,750, and the other of the Allgemeine Electrical Company, of Berlin, for £10,076, the Corporation chose the latter for acceptance. Considerable dissatisfaction was expressed at this decision, and in deference to popular feeling, the Corporation decided to insist upon more stringent conditions with regard to the rates of wages paid by the German firm. The main idea of this alteration of the conditions under which the tender has been invited was to insure the payment by the German firm of the Glasgow rate of wages for all work done. No advantage has been gained by the new conditions, for it happens that while the Glasgow rate is $8\frac{1}{4}$d. an hour, the rate paid in Berlin is stated to be 8½d. per hour. It should be remembered, however, that while scales of wages for different classes of work in this country are very carefully defined, a similar state of things does not exist in Germany, and we are very much inclined to doubt whether the rate of wages paid in Berlin on this contract will reach the average value stated for the information of the Glasgow Corporation.

❧

To see or not to see.

It is not everyone who can catch the slight increase in glow which tells that N rays are impinging on a luminescent screen. The phenomenon manifests itself only to the chosen few endowed with good eyesight who instinctively possess, or have acquired the patient art of "looking" at the screen. To some the brightness of a screen appears to come in pulses, whether there be N rays or not, to others a mere change in position brings a change in perception. This is probably due to individual peculiarities in the structure of the eyes, or as Sir William Crookes suggests, to the fact that the different parts of the retina are not all equally sensitive. The difficulty may be further complicated by the presence of N rays, by the fact that the screen is not quite normal to the observer, by an excessive or deficient "sunning" of the screen. The neophyte need not despair, however, as M. Charpentier, whose recent experiments astonish even the most acute observers in this field of research, was months before being able to detect even the smallest change. At any rate the subject is fraught with promise for the lucky searcher who can see at first sight, and the number of observers will probably increase, as from recent discoveries it is evident that we are about to enter the domain of practical application.

In a recent visit to M. Blondlot, Sir William Crookes was able to witness the delicate experiments by which the French physicist has established the existence of N rays. The effect on a star shaped screen of a file and other objects, and of such auditory phenomena as hissing, handclapping, talking, etc., were successively examined. Next a sharp edged object was placed on a screen, and the effect of the rays on the apparent sharpness of the contours was observed. The dial of a clock placed in the laboratory was made use of to note the effect of the rays on the visual organs, and lastly a pencil of N rays refracted by an aluminium prism was made to fall on a small slit filled with calcium sulphide and placed on a movable choriot in front of the prism, the observer being thus enabled to examine successively rays of different indices. These experiments were all carefully noted by Sir William who evidently wishes to repeat them in identical conditions in his own laboratory at home.

❧

Openings in the Electrical Profession.

DEFINITE information is often desired as to the educational and other qualifications that are most useful as aids to the young electrical engineer, and as to the departments of electrical work that afford the best opening for a successful career. An inquiry recently instituted among one hundred of the leading electricians in Chicago, engaged in different branches of the electrical industry, has afforded some interesting results, which are fully stated and discussed in a paper recently read before the electrical section of the Western Society of Engineers. The inquiry was confined to men between the ages of twenty-seven and forty-five, the average age being thirty-three and a half years. From a diagram given in this paper, we find the average income starts with a value of £434 at the age of twenty-seven, and extends to £800 at the age of thirty-eight. Analysis of the replies shows clearly that salesmen who possess technical knowledge and ability obtain higher salaries than those who do not, while those who add initiative and executive ability become sales managers with still better pecuniary reward. Enterprise and energy, in addition, put the engineer in possession of his own business, or result in a partnership. It also appears that technical ability without the commercial instinct is remunerated at a comparatively low rate, but ability to develop new methods places the engineer in the expert class, where the rewards are greater and in proportion to ability. Routine work is the least remunerative employment of all, although managers and superintendents are well paid. In the field of consulting electrical engineering, the average age is greater than in the others, which, of course, implies that the successful consulting engineer possesses long experience, and that consultative practice is therefore not a branch of the profession to be recommended to the beginner. Out of the list mentioned, forty per cent. are engaged in the employ of large electrical companies; thirty-five per cent. either control, or are partners in, the businesses with which they are connected; and twenty-five per cent. are not college graduates; while twenty per cent. are entirely without college education. It must be observed, however, that those who have prospered without the benefit of technical education owe their success chiefly to business enterprise, and that there are few non-technical men engaged in technical parts of the electrical profession who have attained the average income. There appear to be more openings for men without adequate college training in connection with telephones than in other departments of electrical work, and, finally, it appears that out of the electricians selected for this inquiry, only fifty-six per cent. belong to the American Institution of Electrical Engineers.

The War and the Wireless.

Although it is known that wireless telegraphy is being used on both sides in the present war between Japan and Russia, no definite announcement as to its value to the respective users is likely to be deducible for quite a long period. During the course of the war, naturally, even the general facts which are allowed to leak out—as the statement that Admiral Togo employed wireless telegraphy in the manœuvres which eventually led up to the destruction of the Petropavlovsk—will be unreliable, and it is only after the conclusion of peace that a critical survey, with possibly some reliable data, may be hoped for, published by those in possession of the facts.

This being the case, it is with the greater interest that we turn to the use of this new form of communication in warfare by non-belligerents, *i.e.*, newspaper correspondents. The story of the equipment of the *Times* despatch boat is graphically related in one or two of our American contemporaries, and reads more like the hasty fitting out of a piratical enterprise than the calm completion of a stroke of modern business foresight, for which the *Times* is to be heartily congratulated. It is related, that by the arrangements made between the *Times* special correspondent, Capt. James and the De Forest Co., two complete sets of apparatus and two expert operators were to be sent to the front. Within ten days the apparatus was shipped to Vancouver, just catching the liner "Empress of Japan." The small steamer Haimun was chartered at Shanghai, and on its way north to Wei-hai-wei, the operators worked unceasingly in fitting up the apparatus on board, topmasts 75 ft. in height being put up for the antenna. On arrival at the northern port they found a bamboo pole arrangement 180 ft. high had been already rigged up, and the machinery had to be transported thence, to a spot about 10 miles from the town, entailing great difficulties owing to the rocky nature of the ground. Within three weeks, wireless messages appeared printed in the *Times*, so that much time was not lost. Each set of apparatus is of 1 kilowatt capacity, and comprises a 2½ h.p. Secor oil-engine, a 60 cycle 500 volt generator with separate exciter, a 20,000 volt oil-transformer, oil-break key, Shoemaker de Forest oscillator and syntoniser, electrolytic receiver with relay and bell, and telephone receivers for the messages. On the Haimun itself a similar oil-engine was installed, owing to the vessel being unprovided with electric power.

It appears that the apparatus has given complete satisfaction, and over here it has provided us with some of the most graphic and at the same time most lucid accounts of the recent naval engagements.

The chief point of interest at the moment is the situation created by the recent Russian proclamation that all wireless instruments will be liable to seizure, and all operators to capture and treatment as spies. The de Forest Co. has, naturally, in the interests of its operators, drawn the attention of the U.S. Government to this declaration, pointing out that the operators are American subjects. With the question of right or the definition of the operators' position under International Law we have nothing to do, but it is difficult to see how such a use of wireless telegraphy is disadvantageous to either of the belligerents, provided the *Times* correspondent keeps to merely giving a record of events. This seems to have been the view of the Russian Naval Authorities themselves until recently, for the Haimun was overhauled a few weeks ago, and the Russian officers withdrew after inspecting the wireless apparatus. Something of course may have transpired in the meantime which has caused them to change their views, and it is easy to understand that any use of the apparatus for recording the movements of ships or transports might convey information of value to either side, as the signals being transmitted in Morse code would be legible by any one.

A special code could, however, be compiled by the de Forest Co. for use in such messages. As neither belligerent would be conversant with the code, neither would be able to derive benefit or information from such messages. Messages dealing with actions which have taken place could naturally be sent as usual in the ordinary Morse code. If the Russian authorities consider such a use of this means of communication to be detrimental to their interests, they clearly can endeavour to stop it by siezing the apparatus (the operators themselves they would not interfere with), for after all, business is business, and when war is necessary it is not merely a business, but a very serious business.

⁂

The London Traffic Problem.

IT was hardly to be expected that the Royal Statistical Society, when considering Mr. E. J. Haiper's valuable and suggestive paper on the "Statistics of London Traffic," should do so from aught but the purely statistical one of comparative figures. A great deal of the data, which has been so laboriously compiled, does not lend itself to reproduction in our columns; but certain of its figures appeal with much interest to engineers. Questions of profit, municipal politics, and so forth were rigidly excluded. Indeed, one might have imagined, so far as the contents of the paper were concerned, that municipal trading was non-existent, that railway directors (tube and steam) never had to consider costs per train mile or the dividends expected by their shareholders. True, there was one reference to current events—to the Royal Commission on the Means of Locomotion and Transport in London, on account of which Mr. Harper attempted to bring together and classify the best of the available statistical material. Of the forty tables and three appendices, the seventh—dealing with the chronic conditions of overcrowding between 6 a.m. and 10.30 a.m.—is of special interest to electrical engineers, who could largely increase the number of trains and limit this evil. No less than 14·2% of the inward morning trains are overcrowded, carrying 16·7% of passengers in excess of the seating accommodation. No particulars were given as to overcrowding on the tube lines, but the following figures were advanced:

WORKMEN'S TRAINS ON EACH LINE.

Railway.	Total No. of Workmen's Trains Run Daily in Dec., 1902.	No. of Miles Run Daily by Workmen's Trains.	Percentage of Total Mile'ge Run by each Company.
South Eastern & Chatham	130	1,072	17·8
London & South Western	79	809	13·4
London, Brighton & South Coast..	68	594	9·9
Metropolitan ..	76	586	9·7
,, District	69	575	9·5
Great Eastern ..	110	547	9·1
Central London..	85	504	8·4
City & South London	68	395	6·6
Great Western ..	31	269	4·5
North London ..	40	238	3·9
London & North Western	16	173	2·9
Great Northern..	12	121	2·0
London, Tilbury & Southend ..	12	84	1·4
Midland	5	52	0·9
Totals ..	801	6,019	100·0

The persistent falling off in 1903 is curious—on the City and South London it is perhaps due to the competition of the new L.C.C. trams. Mr. Harper hazards the statement that locomotion on the surface will prove the more attractive in the long run, in spite of the speed attained in tubes. The omnibus traffic, it may be remarked, still attains high figures:—

Year.	*No of Omnibuses entering the City during one day.*
1881	6,176
1891	10.389
1895	12,236
1903	11,630

ELECTRICITY AT ST. LOUIS EXPOSITION, 1904.

Wonder of the Lightning.
(Statue, Palace of Electricity.)

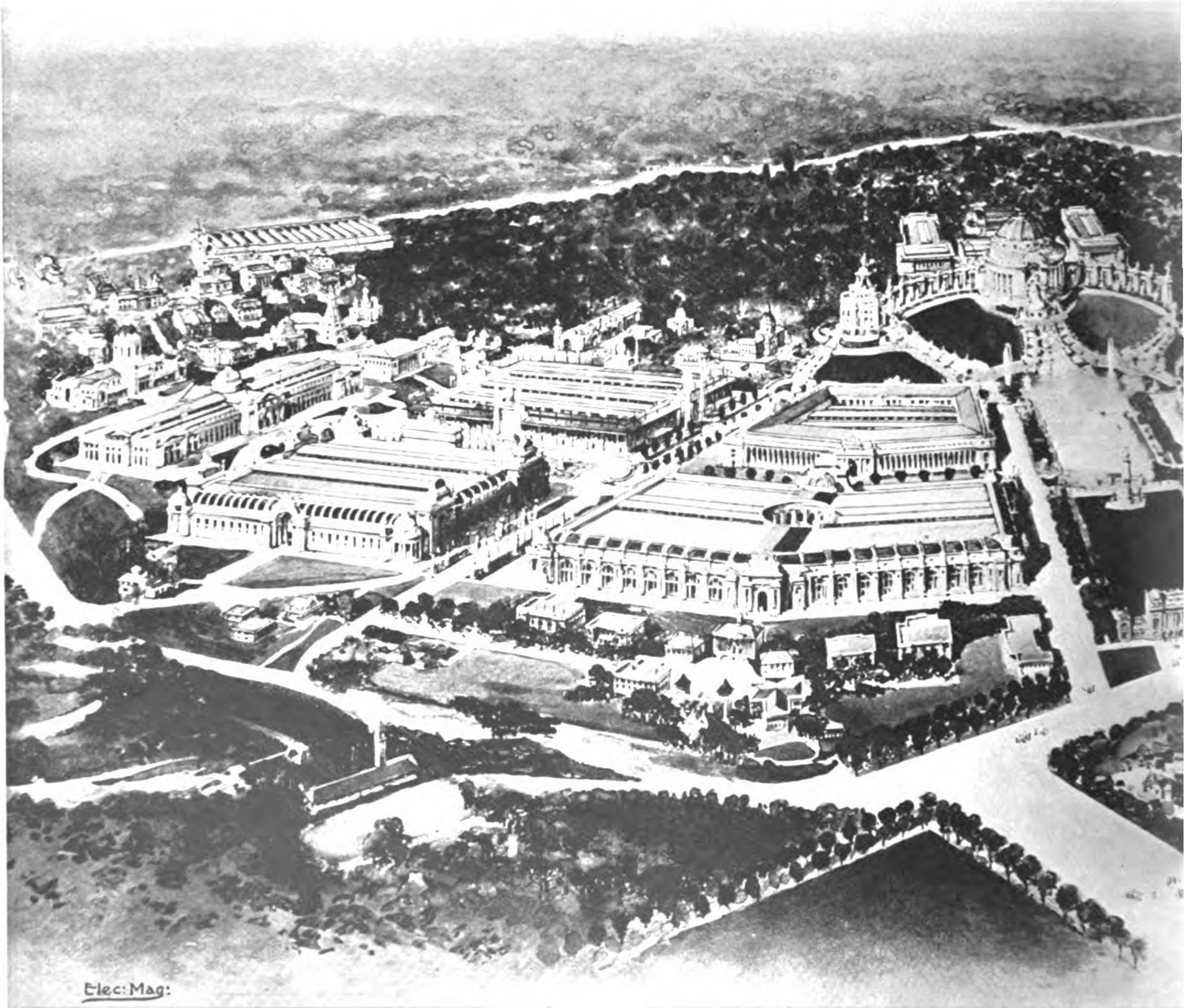
The electricity exhibits at St. Louis will be an education, not only to the professional engineer, but to his lay *confrères*. The assembly of the chief pieces of apparatus in the Palace of Electricity will be no mere jumble of dynamos, engines, cables, etc., but a distinct aggregation of electrical machinery, so displayed as to convey clearly structural details and functions, leaving no doubt in the mind of the idea to be conveyed. The management decided upon this course as that most suited to banish the element of mystery so commonly associated with electricity and its kindred apparatus. To familiarise the public with electricity and its possibilities, to the extent it is now acquainted with the functions of steam, oil, and gas, and thereby elevate lay knowledge of the subject to the standard of unconscious acceptance, has been the aim and object of those responsible for this gigantic collection of typical electrical appliances. It has been assumed—and rightly—that the growth of this young, but flourishing, industry depends—and will even more depend—on the public's knowledge of the laws governing its productions, and that when popular assent, born of popular recognition of the facts, is given to the wider expansion of electricity in industrial circles, the future of that industry will be assured. Prof. W. E. Goldborough, whom we quoted in our last issue, is largely responsible for the attitude prompting this presentation of the facts, and little thought is necessary in anticipating the result.

Last month we glanced lightly over the objects of the exposition, and gave a few details of its electrical features. In this issue we publish several striking illustrations of the electricity building, together with a bird's-eye view of the entire exposition. On the cover will be found a reproduction of the magnificent group, entitled "Light and Darkness," which crowns six towers of the electricity building.

Situated several thousand miles from the spot, it is difficult for British manufacturers to enter any heavy exhibits, consequently, several representative firms have been chosen to submit types of lighter manufactures, and details of these will be found on another page. America is, naturally, well represented; in fact, the bulk of the Palace of Electricity is occupied by American firms. Of these, the largest individual exhibit is that of the General Electric Co., covering a quarter of an acre of floor space, the majority of the apparatus being shown in operation. (Block 28 is allotted to this exhibit. See page 349, *The Electrical Magazine*, No. 4, Vol. I.) The Edison exhibit (26, 27. See note above) includes, among a historical collection of great merit, the iron nickel storage battery. Among the largest exhibitors are the Westinghouse Co., who also are showing their one-phase railway. Out of a multitude of exhibits it is difficult to select the most interesting, but some novelties will be presented, and which cannot be overlooked. A wireless telephone installation will be in operation in the building, and, as an offshoot in this particular, a small booth, in connection with a number of wires strung around the court of the palace, will be fitted with a special telephone transmitter. Music will be played before this transmitter, and, by the aid of a pocket receiver, the music can be heard in the court, there being no mechanical connection with the overhead wires. Without the receiver the sounds are inaudible. The De Forest Co., in addition to a large tower of 325 ft. for long distance wireless telegraphy, have three towers of 75 ft. in the Palace (19) for communication with other stations in the building, and with the central tower above mentioned. High speed telegraph systems, transmitting typewriters, and the Gray telautograph will be shown in operation. Automatic telephones (see page 502 of this

Bird's-Eye View of

(This should be studied in conjuncti



STATE BUILDINGS.
MISSOURI STATE BUILDING. LIBERAL ARTS.
UNITED STATES BUILDING.

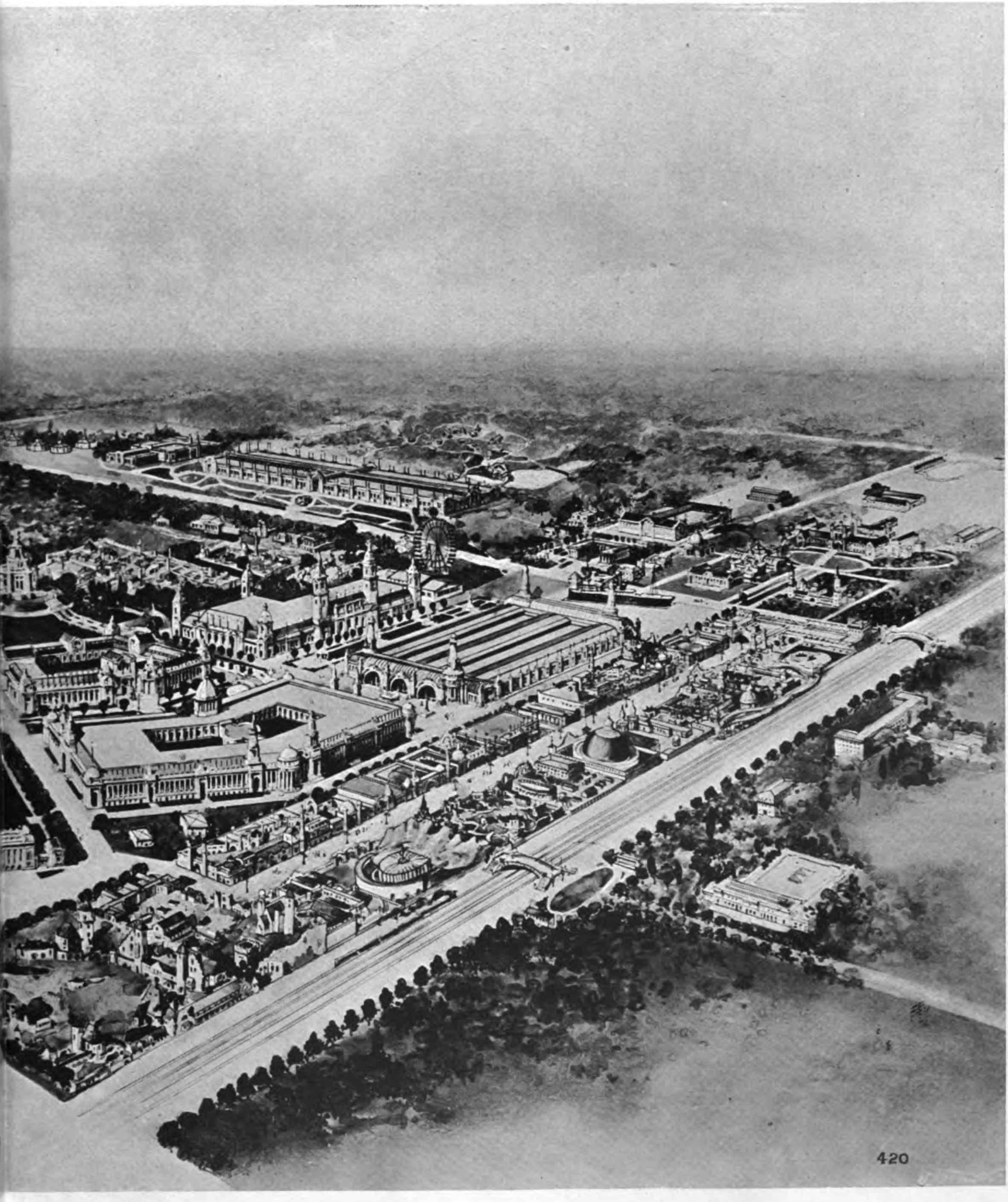
OUTSIDE MINING.
MINES AND METALLURGY.

MODEL STREET.

EDUCATION. PALACE OF A
MANUFACTURES. FESTIV
CASC
GRAND

St. Louis Exposition.

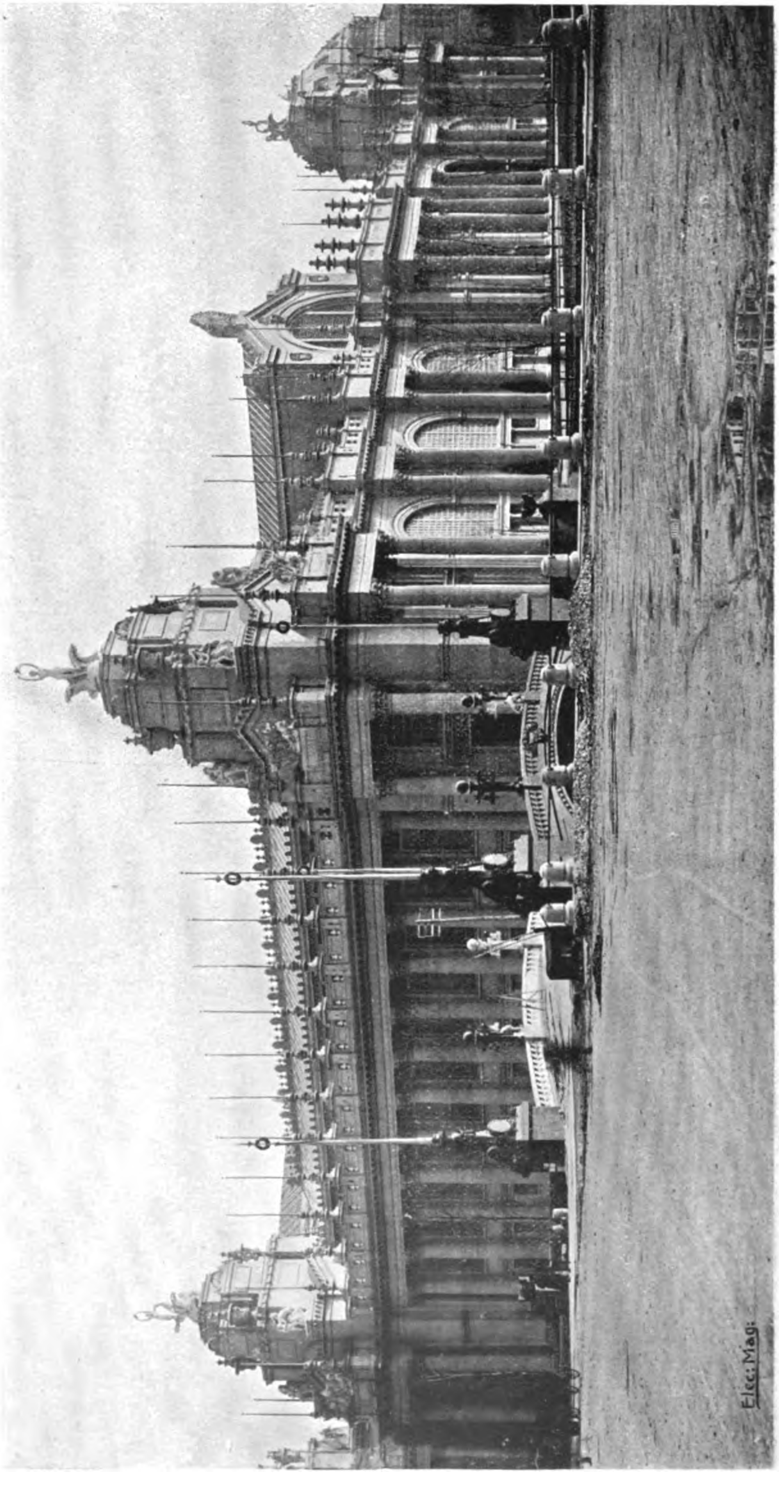
with the Map on page 350, No. 4.)



A CORNER OF THE PALACE OF ELECTRICITY.

issue) will be in evidence and their practicability demonstrated. Of the remaining exhibits we must crave our readers' patience until we are able to give detailed illustrated particulars of them. We are making special arrangements to procure all possible information, consequently, can promise beforehand a reliable and comprehensive account.

France occupies the premier position, for space allotted, among foreign exhibitors, the floor area of the exhibit being



Palace of Electricity, St. Louis Exposition.

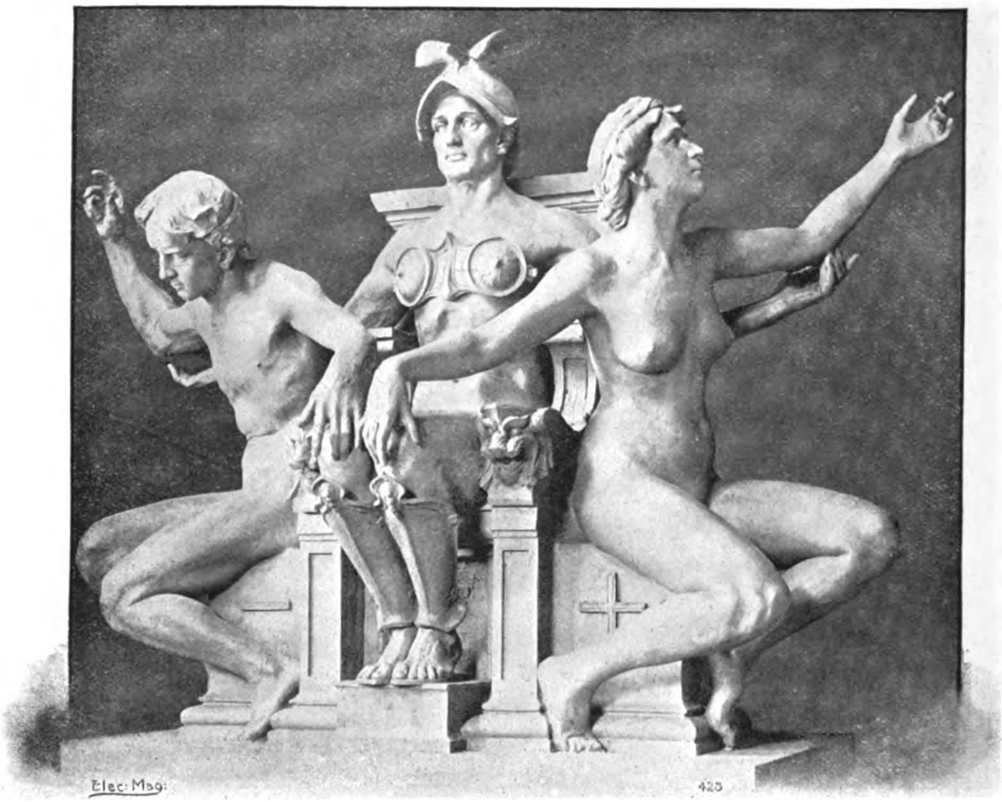
25,000 square feet. The Société Alsacienne de Constructions Mecanique will exhibit a slow speed engine and generator 1,000 hp. output, and as a contrast, the Sociétés Delannay-Belleville and L'Eclairage Electrique exhibit a high speed set of 1,500 hp. The first mentioned company is showing a special form of multi-speed alternate-current motor. The Société Gramme will display its earliest machine of 1869, by the side of the modern types it now manufactures, the evolution from the primitive machine being depicted by a carefully arranged series. The Dolter system of surface contact tramway is on view, and the remaining exhibitors (there are 100 in all) are chiefly concerned with primary batteries, carbons, lighting effects, insulators, etc. Richard instruments figure prominently in this branch, and the Blondel oscillograph will be included in the exhibit of that eminent scientist. Germany will be also well represented, the chief exhibit illustrating the growth of German chemistry and electro-chemistry during 150 years. The entire exhibit contains purely German inventions and products, and the portion just mentioned was put forward for educational purposes only. Japan, though at war with Russia, has a representative exhibit, the first of its kind, of electrical apparatus of strictly Japanese design. A 150,000 volt testing transformer, built at Tokio by Mr. Ijimas, is a great attraction. The Oki Company, Tokio, are the chief exhibitors, and the Japanese Electrical Association furnishes a statistical table of the electrical industry in Japan. Apart from Great Britain, there are small exhibits from Mexico, Spain, Brazil and Denmark.

The British electrical industry is represented by a few firms who send typical examples of their manufactures, but no organised attempt has been made to exhibition a large scale. While in no way indicating the status of the electrical industry in this country, the British exhibit testifies to our interest in the exhibition and good feeling towards the United States.

The space allotted comprises several thousand square feet to the right of the main entrance of the Palace of Electricity. The exhibit, chiefly composed of instruments, has already been set up.

The following is an alphabetical list of British exhibitors and their exhibits:—

F. B. Behr.	Model of high-speed Mono rail and car.
Consolidated Electrical Co. Ltd.	Switches and switchboard apparatus, telephones and telephone apparatus.
Sherard Cowper-Coles Co., Ltd.	Standardising, parabolic reflectors (see p. 511), centrifugal copper process, electro galvanising.
A. C. Cossor.	Electric lamps.
Cambridge Scientific Instrument Co.	Oscillographs, resistance thermometers, Callendar's electric recorder, standard resistances, etc.
Crompton & Co., Ltd.	Potentiometer, Wheatstone Bridge, galvanometers, mangani resistances.
Darton & Co.	Induction coil, improved dynamo, ventilating motor, new reversing motor.
Elliott Bros.	Double Astatic Thomson galvanometer, Wheatstone Bridge, low resistance potentiometer, portable wattmeter, multiple range current transformers, and other instruments.
Everett, Edgecombe & Co.	Various switchboard ammeters, and voltmeters, and other instruments.
General Post Office.	Morse embosser (1853) Inkwriter (1860) Wheatstone automatic duplex, quadruplex, etc.
India Rubber, Gutta Percha & Telegraph Works, Co., Ltd.	Samples of submarine cables, Raymond Barker calculator, etc.
Kelvin & James White, Ltd.	Electric balances.
Muirhead & Co.	Thomson's syphon recorder, Muirhead's syphon recorder, combined recorder and suspended coil galvanometer, and other instruments.
Nalder Bros. & Co.	Ayrton and Mather shunt box, motor driven secohmmeter, Hopkinson's permeameter, and other instruments (36 in all).
Nalder Bros. & Thompson.	Portable standard ammeter and voltmeter, portable combined ammeter testing set,



STATUARY GROUP FOR PALACE OF ELECTRICITY.

Nalder Bros. & Thompson *(contd.)*	and other instruments (22 in all), high tension instruments with transformers.
R. W. Paul.	Standard resistance coil (1 ohm), standard megohm, standard series resistance box, and other instruments (26 in all).
The Synchronome Co.	A system of electrically propelled dials controlled by a self wound pendulum (in motion).

Space will not permit us to give further details of these exhibits, but in our next issue we shall give illustrations of several interesting groups of the instruments exhibited.

Apart from the electrical apparatus exhibited in the Palace of Electricity, the Machinery Hall will contain a number of combined units of large size, among these being an Allis-Chalmers unit of 3,600 kw. Those visitors, not necessarily electrical engineers, who are interested in the instructive character of the apparatus on view in the Palace of Electricity, can inspect machinery similar in principle, but on a larger scale, and in operation in the Machinery Hall.

The illuminating effects of buildings, gardens and terraces will be carried out on a superb scale by electric lamps, and electricity as a motive power will also be extensively used. The cascades below the Festival Hall—the "hub" of the exposition—will be supplied with water from three large centrifugal pumps, each driven direct by a 2,000 hp. induction motor. Other motor applications will be described in subsequent issues. The illustrations reproduced herewith are the copyright of the Louisiana Purchase Exposition, but through the kindness of the secretary we are permitted to make use of them. We take this opportunity of extending our thanks.

SPECIAL ARTICLES

The articles under this section being of general interest to electrical men, are not classified under the ordinary sections of the magazine.

ON THE WINDINGS OF ALTERNATOR ARMATURES.

By A. C. EBORALI, M.I.E.E.

In the first number of *The Electrical Magazine* (January, 1904), the writer discussed certain matters relative to the development and construction of polyphase generators, and in the present article it is proposed to deal with a matter arising therefrom, namely, with the properties of former wound coils *versus* hand wound coils for alternator armatures.

The revolving field machine is nowadays the standard type of alternator for all important work in every country, but, as already pointed out in the above mentioned article, the details of design differ very widely, in accordance with the ideas of the different designers. As far as the winding of the armatures is concerned, however, there are but two classes to be considered, namely, the winding in entirely open slots, and that in partly closed or in entirely closed slots. The former implies the use of former wound coils and laminated pole shoes, and is standard American practice, while the latter implies hand wound coils and (as a general rule) solid pole shoes, which corresponds to the general practice in Europe.

It would appear at first sight that, with a given number of armature conductors and slots per pole per phase, the former wound winding presents considerable advantages over the hand wound winding; it would be thought, for instance, that not only is the risk of breakdown less in the first case, due to the greater ease with which a former wound coil can be insulated, but that if an accident should occur, the burnt out coil or coils could be more quickly replaced, with the help of spare coils kept ready for such occasions. But on going closely into the matter, it will be found that a number of considerations have to be taken into account which modify the above views very considerably.

For the purpose of studying this matter, it is necessary, first of all, to distinguish between alternators having bar-wound armatures, and those having armature windings consisting of coils wound with several turns of either solid or stranded wire, the conductor being either of circular or rectangular section. Most alternators built for low pressures are provided with windings of the first mentioned character, there being one, or at the most, two bars per slot. These bars (of different lengths) are either quite straight and connected up at the ends by means of ⊓ shaped connectors, or are bent at one end before being slipped into the slots, with the object of reducing the number of end connectors necessary, and hence the number of joints also. With such bar windings, however carried out, there is very little to choose,

—from the point of view of ease of repair—between open or closed slots; in both cases joints have to be unsoldered or unscrewed and afterwards re-made, should a renewal of a portion of the winding be necessary. The renewal of the bars affected can be made as readily in the one case as in the other, as in either case they can be withdrawn or inserted (in the axial direction of the machine) with great facility.

And, bearing in mind that accidents to the windings of such low pressure alternators are of very rare occurrence, it would appear that, taking into account the electrical disadvantages mentioned below relative to the employment of open slots in general, in conjunction with the fact that such bar windings can be far better held in the slots when these are partly or wholly closed than when they are open, entirely or partly closed slots are generally preferable for machines in which the armature windings are bar wound.

It is, however, more particularly with regard to the second class of winding that the matter must be closely considered, for all high pressure alternators have coil wound armatures; not only have designers mostly to deal with such alternators, but the question of effective insulation becomes with them of the greatest importance, and the facility with which coils can be renewed is also an important consideration.

Where the armature coils are hand-wound in holes or partly open slots, the slot insulation consists of *seamless* tubes, either of micanite, or of compressed paper, or of a composition tube built up of paper and mica; in any case, however, these tubes, as turned out by one or other of the factories making a speciality of such insulation, can be regarded as being practically fireproof, waterproof, and oil proof. In addition to the effective insulation of the windings from the core which it is the special function of the tubes to fulfil, the necessary care has to be taken with the insulation and braiding of the conductors themselves, as with hand-wound coils the conductors have to be threaded through from one end. With a poor or unsuitable insulation on the wires, abrasion of the insulation might take place unnoticed during winding, with the risk of internal short-circuiting of the individual layers after the machine is put into service. But above all is it necessary to allow the tubes

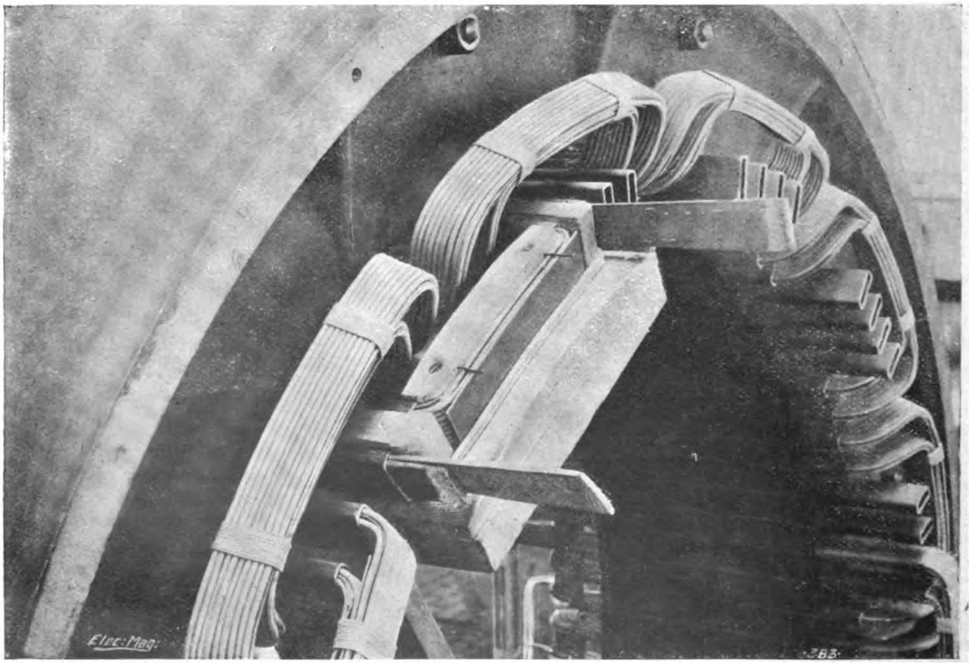


FIG. 1.
Illustrating the method usually employed when winding in the coils of hand-wound alternator armatures.

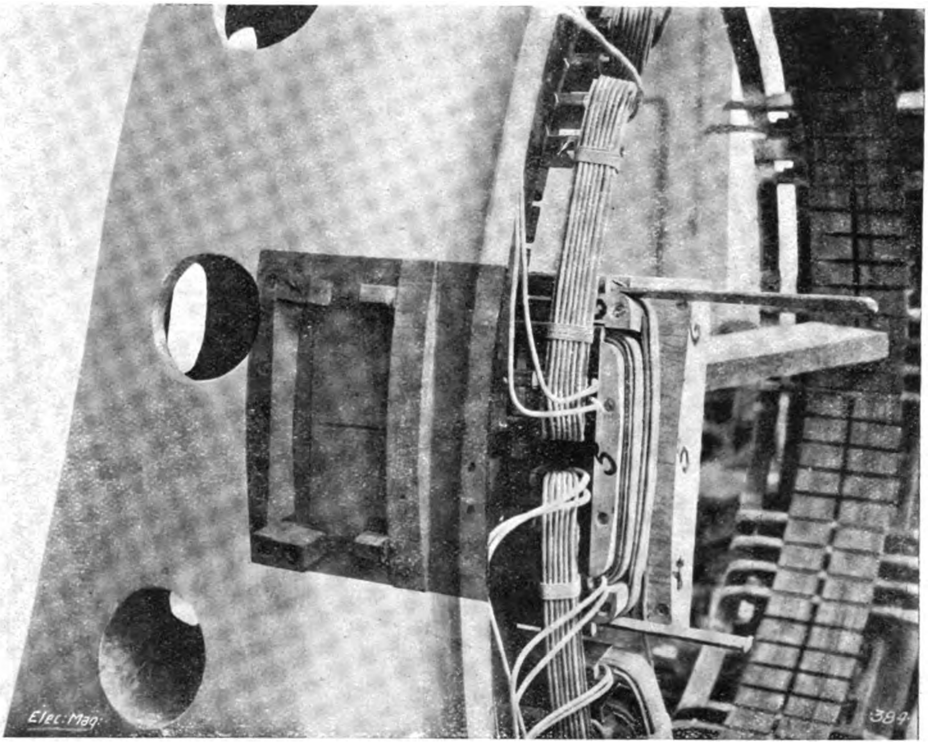


Fig. 2.

A further illustration of the winding in of armature coils by hand.

(*Note.—A portion of the alternator carcase is shown transparent, in order that the former may be seen*).

of insulating material to project sufficiently at the ends of the armature, as it is at the tube end that the danger of arcing to the frame is the greatest. And in this connection it may be pointed out that the proper insulation of the coil ends is far more readily attained by preserving adequate distances between these ends and the core and the case than by reducing these distances, and insulating the ends with the various tapes, oiled cloths, etc., so much favoured by certain designers. It is true that in the latter case, the alternator can be built a few inches smaller, but on the other hand, the cooling of the coil ends is retarded. In the former case the cooling of the ends is not impeded, for given proper distances, two or three layers of prepared tape, afterwards varnished, is all the covering they require.

In alternators of modern and up-to-date design, in which ample room is allowed in the holes for the windings, the renewal of a burnt out coil is neither a difficult nor a lengthy operation, and consequently it is quite unnecessary to entrust this work to a skilled winder; it can in fact be carried out by any workman with common sense and an ordinary working knowledge of electrical machinery. The accompanying illustrations, Figs. 1 and 2, show very clearly the mode of procedure usually adopted for winding in a new coil or coils in the case of a three-phase closed slot armature. If the alternator is too large to permit of the removal of the field system, and if no provision exists for moving the armature sideways, clear of the magnet wheel, it is first of all usually advisable to remove two or three field poles sideways, in order to provide space for the former, and to give the men more room to work on that portion of the armature affected.* Then, after removing the damaged tubes and replacing them by new ones, and with the help of the simple wooden formers shown in Fig. 3 (for the case of polyphase alternators, two shapes

---

* In many cases, however, this removal of the adjacent field poles is unnecessary.

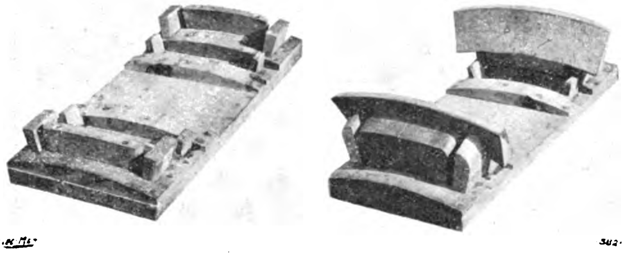


Fig. 3.
Wooden formers used in winding the coils of alternator armatures, having wholly or partly closed slots.

of former have to be provided, corresponding to the straight and bent coils) the new windings can be put in with very little trouble. The time taken is of the order of two to three hours per coil, depending upon the number of turns in the coil, its position on the armature, and whether the two men carrying out the work have wound similar coils before. Seeing, moreover, that the coil ends have not to be insulated in the best designs, but simply taped over, the alternator is practically ready for service again as soon as the coil is wound and connected up.

Coming now to the case of alternators having former wound coils in open slots, it may be pointed out that however these coils are made, they present certain disadvantages either from the point of view of insulation, or from the mechanical point of view, and the higher the pressure, and the larger and heavier the coil, the more these disadvantages are felt. The various ways in which such former wound coils are made nowadays are dealt with below.

One method consists in employing open micanite troughs as the slot insulation, the coil being directly placed therein; a boxwood or fibre wedge is in this case employed to secure the coil in the slot and to complete its insulation. The weak points of this arrangement exaggerated are marked "*a*" in Fig. 4, and it is these (assuming that the coil ends do not go) that invariably cause the coil to break down sooner or later. The trouble can be partly got over by enveloping the whole coil with prepared tape, paper, or similar material; as, however, the wooden wedge cannot have a greater length than the width of the armature core, it has to be continued by a suitable thickness of insulating material (Fig. 5).

A second method consists in employing split micanite tubes, which close along an oblique line (Fig. 6). This arrangement does not present the same weak points as that of Fig. 4, but when such a coil is placed in the slots, the insulating tubes (which must in any case possess a certain flexibility) are subjected to considerable stress at the points marked "*bb*," and owing to this, the tubes are quite likely to sustain sufficient damage to lead ultimately to a breakdown of the coil. With this method again, it is very necessary to see that the coil is kept to the right dimensions, as otherwise the tubes could not be closed without injury.

A third method, shown by Fig. 7, consists in employing half-closed tubes of insulating material; the weak points are marked "*c*," and it will be noticed that the method is very little better than that already indicated in Figs. 4 and 5.

A fourth method of preparing former wound coils for use in alternators having open slots consists in using seamless micanite tubes, which are held by the former, and the winding then put in (that is, threaded through) in an exactly similar manner to the winding in of a pure hole winding. Although this avoids difficulties with regard to the effective insulation of the coil, the method is expensive, and open to the general objections referred to below, and is consequently very little used.

In the last method to be referred to, the coil itself, after winding, is so thickly wrapped around with flexible insulating material, such as oiled cloth, canvas, or paper, micanite paper, etc., that no tube of insulating material is necessary. After being insulated in this manner, and finally taped, the whole coil is impregnated with

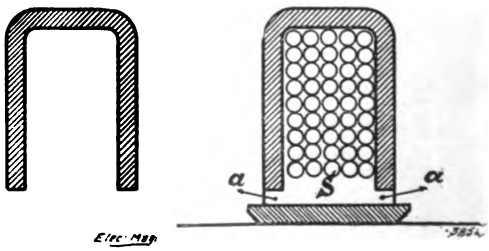


Fig. 4.

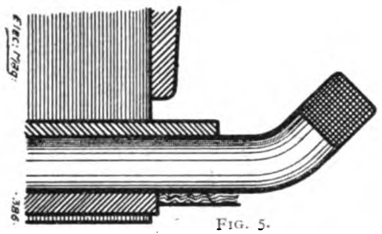


Fig. 5.

a special varnish and baked in a vacuum. This method is probably the best of all, and if the coils are properly made, an excellent job can be made of them. Seeing, however, that the finished coils must be of perfect shape, with the insulation of uniform thickness throughout, only the best coil makers of great experience can be employed for making them; the quality of the insulation and the future success of the finished armature are, moreover, wholly in the hands of these men, who, if a really satisfactory winding is to be produced, must put more conscience into their work than that absolutely necessary to get their coils through the pressure tests.

No matter how former wound coils are made, their insertion into the open slots of the armature core necessitates considerable care. On the one hand, the requirements of the electrical design of the armature allow very little play between the coil and the sides of the slots, and on the other hand, the insulation of the coil is of a delicate nature, and the coil itself, particularly if of large size, is unavoidably weak mechanically. Not only then, is it necessary to place both sides of the coil simultaneously and very carefully into the slots, but in most cases it is necessary to go over the coils after they are in position, and renew or repair any portion of the insulation which may have become damaged during the process of insertion. In this connection it is hardly necessary to add that, if any portion of the coil actually in the slots gets damaged (such as the insulating tube or covering cracking) the whole coil is done for at once, and the work has to be done over again.

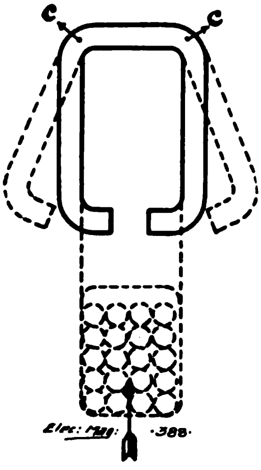


Fig. 7

Experience with former wound coils shows that it is a very difficult matter to remove a coil from the slots, should this be necessary, after the alternator has been in service for some time. The point is of considerable practical importance, for with polyphase machines, it is necessary to remove the straight coils before the bent coils can be got out, and hence, should an accident occur to one or more of the latter, several good coils will have to be removed in addition. After an armature winding has been for some time in use, and even if the coils when first put in are an easy fit in the slots, the alternate heating and cooling to which the coils are subjected causes them, not only to become a very tight fit in the slots, but to adhere to the sides and bottom of the slots, due in all probability to the varnish, etc., baking out and running into the spaces between the laminations; the core and winding often become, in fact, nearly a solid mass after having been in active operation for some time.

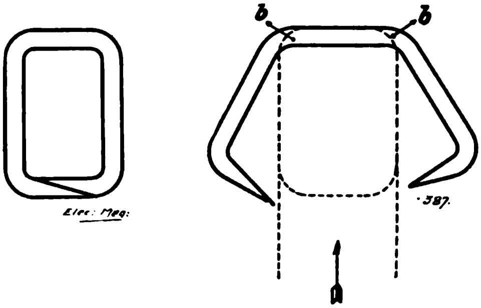


Fig 6.

To effect a repair on an armature having open slots and former wound coils often means then, something more than the mere renewal of the part affected. The damaged coil or coils have to be got out, which may entail the removal of several good coils, and some at least of these are likely to become damaged themselves during the process; in addition to this, there is the risk of damaging the new coils which have to go in (as well as the good coils temporarily removed), when they are being placed in the slots. And the unfortunate part of it is that it is not always easy to see when a coil is damaged, or to know that a coil has sustained damage during insertion; generally speaking, it is not until the plant is started up again that the damage, if any, is made apparent, which means that the whole operation has to be gone over again. On account of the above, it is always advisable to test each coil with a pressure of double the working pressure applied between the conductors and the frame, after it has been inserted and keyed into its slots, and before the connections to it have been made, or the remaining coils put in. The few minutes required for this test are well spent, and may save much annoyance and loss of time afterwards, and for the rest, the necessary means are, or should be, to hand, in every high pressure supply station.

What has been said above, with regard to hand-wound coils in holes or partly closed slots on the one hand, and former wound coils in straight, open slots on the other, gives a basis upon which the two systems of winding can be compared from the points of view of construction, freedom from breakdown during operation, and facility for repairs. But other matters have also to be considered, before an opinion on the whole question can be formed, which will now be very briefly referred to. In the first place, it is clear that the revolving magnet wheel will be better mechanically if built solid throughout, that is, if it consists of a cast steel or cast iron body, to which are bolted the cast steel poles, with the pole-shoes in one piece with them. This construction of magnet wheel is the right one for use in connection with all hole wound armatures, and it is perfectly permissible for use with armatures having their windings in partly closed slots, provided that the air-gap is not too small, the number of slots per pole per phase too few, and that the slot opening is less than half its width. Such wheels can therefore be operated at greater peripheral speeds, and with a greater margin of safety at that, than corresponding magnet systems in which the poles are either laminated throughout, or have solid cores and laminated pole-shoes. These latter are an absolute necessity with alternators having former wound armature coils in open slots on account of the heating and losses which would otherwise occur in them.

Moreover, the magnet wheel with solid pole-shoes is, generally speaking, very advantageous from the point of view of the operation of plants running in parallel, on account of the damping effect brought about by the currents which circulate in the solid pole-shoes. These currents are called into existence by the shifting magnetic fluxes crossing the pole-faces as a result of the generator oscillations, and their damping action is usually sufficient to assist proper parallel operation very materially, especially for the case of slow speed plants.

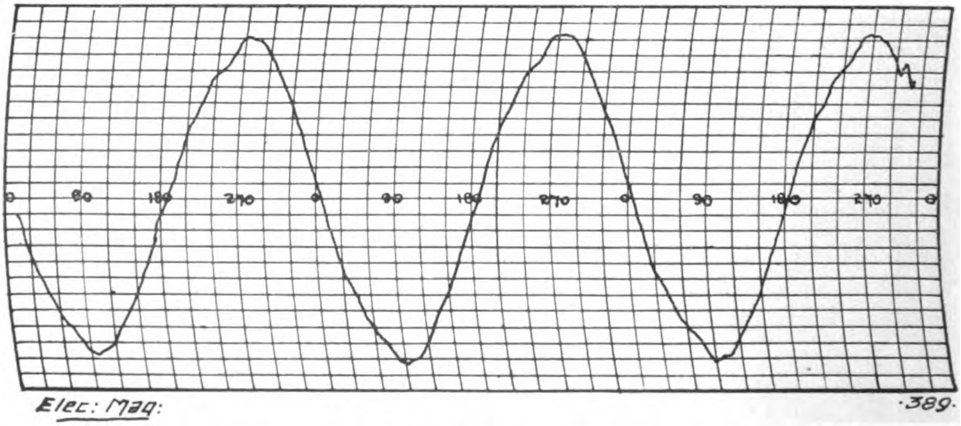


Fig. 8.

Pressure curve of 1,200 hp. three-phase alternator (well loaded), having its armature winding located in two nearly closed slots per pole per phase.

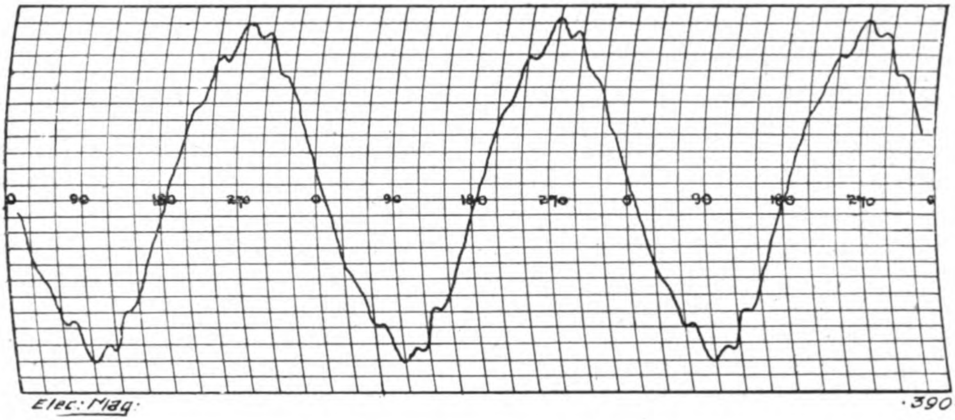


FIG. 9.
Pressure curve of 1,200 hp. three-phase alternator (well loaded) having its armature winding located in two entirely open slots per pole per phase.

Hence from the points of view of the construction of the magnet wheels and of the actual running of the plant in service, the armature with hand wound coils presents undoubted advantages over the armature with former wound coils.

This is also the case from the points of view of pressure regulation and shape of pressure wave. Better pressure regulation can, as a rule, be obtained from an alternator designed on modern lines with hole winding than from one with an open slot winding, because of the increased magnetic leakage at full load compared with that at no load in the latter case, the comparison, of course, being made upon the same basis. And it is equally clear that a much better pressure wave must also result, on account of the irregular distribution of the magnetic flux cutting the armature coils of all alternators having open slots, whereas for the case of machines with entirely closed or nearly closed slots, the flux distribution is much more uniform. It is true that the irregular distribution of the flux cutting the armature conductors of all alternators having former wound armature coils can be improved by increasing the length of the air-gap in proportion to the width of the slots, but even if the air-gap is almost half the width of the slots, irregularities still appear in the pressure curve. A very good example of the superior qualities of the hand wound armature winding in this respect is afforded by the two curves reproduced as exactly as possible in Figs. 8 and 9. These have been recently taken by means of the same apparatus (a Hospitalier ondograph) from two three-phase steam-driven generators respectively, which are practically similar in every respect except with regard to the arrangement of the armature winding. Both alternators were built by the same firm (but at different dates) to the same specification; each is of 1,200 horse-power, 6,200 volts at the terminals, and 94 revo-

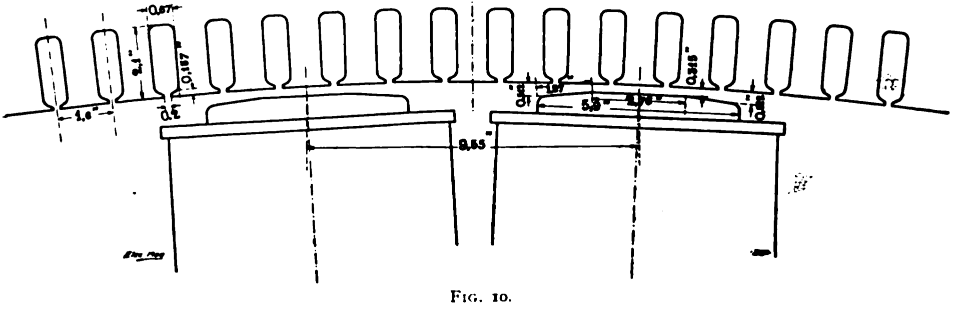


FIG. 10.
Essential details of the 1,200 h.p. three-phase alternator, whose pressure curve is given in Fig 8.

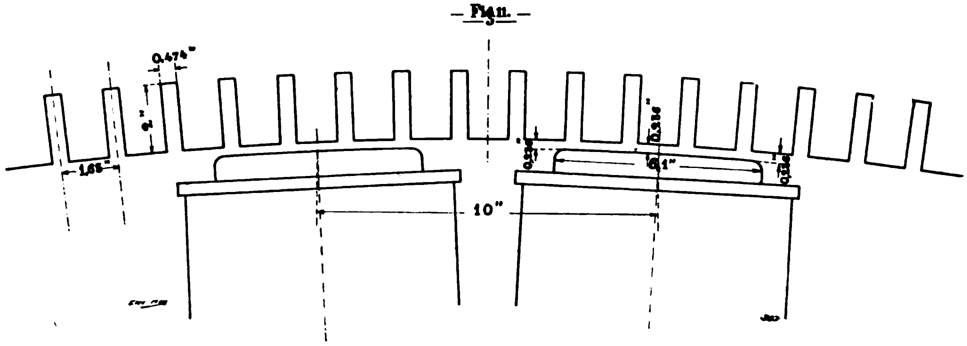


FIG. 11.
Essential details of the 1,200 hp. three-phase alternator whose pressure curve is given in Fig. 9.

lutions per minute. The engines are exact duplicates of one another, and have the same flywheel effect. Figs. 10 and 11 give the essential dimensions of the two alternators, from which it will be seen that there is a slight difference in the frames, giving rise, however, to less than half an inch difference in the pole-pitch (9·55 in. against 10 in.). Otherwise the two alternators are alike, except in the one case the armature slots are open, while in the other case they are nearly closed.

The two pressure curves reproduced were obtained under identical conditions with regard to output and speed, namely, 54-56 ampéres at 6,000 volts and 94 revolutions per minute in each case. Fig. 9 is the curve from the machine with open slots, and Fig. 8 that of the machine with partly closed slots, and it will be seen that whereas the latter is nearly sinusoidal, the former reveals the presence of a pronounced harmonic, which might give rise to undesirable pressure rises under certain conditions of working.

It is not often that such an exact comparison can be made upon large alternators actually in service, both being of modern design and the product of a first-class maker. The two curves, which have been taken with the greatest care, may perhaps be commended to the notice of those engineers who ask in their specifications, on the one hand for alternators with former wound coils, and on the other hand, specify that the machines shall have sinusoidal pressure waves at all loads. The only possible way of reconciling these divergent requirements would be either to "skew" the open slots, or the pole-shoes, but such expedients need not be gone into here, seeing that, as far as the writer knows, no one has adopted them.*

From the point of view of the cost of the winding, there is undoubtedly a considerable difference in favour of the former wound coils in open slots. This is due to the fact that all the coils can be wound in advance, with a minimum of hand labour, while their insulation (assuming, for instance, that the fifth method is employed), is carried out systematically in special departments by a special staff. For the case of large alternators, the coils would be shipped separately and be placed in the slots for the first time after the erection of the machine on its foundations, and generally speaking, both directly, and indirectly, a considerable saving on the labour item is effected in the alternator having former wound coils. This is of advantage to the manufacturer, and explains the wide-spread use of such windings for all classes of work in the States—it is hardly of profit to the user, however, who, moreover, has to put up with all the disadvantages.

The comparison between the two classes of winding given above, can be summarised in the following way, as far as alternators operating at high pressure are concerned.

ALTERNATORS HAVING FORMER WOUND COILS IN OPEN SLOTS.	ALTERNATORS HAVING HAND WOUND COILS IN CLOSED OR PARTLY CLOSED SLOTS.
1. As the slot insulation is not formed of seamless tubes of insulating material, and as the coils are quite likely to be injured during the pro-	1. The slot insulation consists of seamless tubes, inserted without risk of injury, and into these a winding can be put, which will give an absolutely

---

* The slots of the rotors of single and polyphase induction motors are, however, often "skewed" by designers, and for similar reasons.

cess of insertion, the insulation of the armature winding cannot be made so perfect, nor will it be so reliable, especially for really high pressures.	certain result from the insulation point of view. Such a winding can be employed with perfect security for the highest pressures.
2. In consequence of (1), it must be expected that the cost of up-keep of the armature winding will not be a negligible quantity.	2. Repairs to the winding will rarely be necessary, and its cost of maintenance will be practically nil.
3. While the time required for the renewal of a damaged portion of the winding is less, the advantage is more apparent than real, on account of the possibility of not making a good job of the repair, or of damaging adjacent coils when removing them or putting them back.	3. The winding in of new coils takes a little longer, but the result is more certain.
4. Pressure regulation on inductive loads not so good as a rule.	4. Pressure regulation excellent.
5. Magnet wheel renders no assistance to parallel running.	5. Damping effect of magnet wheel considerable, and assists parallel running.
6. Pressure curve contains higher harmonics, which may cause undesirable pressure rises.	6. Pressure curve sinusoidal at no load, and practically so at full load.
7. A certain amount of space is unavoidably lost in the slots, over and above that due to the legitimate requirements of the insulation.	7. Best possible utilisation of the available winding space.
8. The coils, excepting those in the lower part of the armature, cannot be very mechanically held; a thin wedge of insulating material is all that holds them in.	8. All the coils are ironclad and held in a thoroughly satisfactory manner mechanically.
9. Construction of revolving magnet wheel not so good mechanically, because of the laminated poles or pole-shoes and must consequently be operated at a lower peripheral speed.	9. Best possible design of magnet wheel from the point of view of resisting the mechanical and electrical stresses to which it is subjected during running.
10. Coils machine wound and hence cheap; all labour charges directly or indirectly connected with the winding reduced to a minimum.	10. Coils hand-made, which, for this and reasons resulting therefrom, increases the cost of production.

As far as low pressure alternators with bar wound armatures are concerned, considerations Nos. 4, 5, 6, 8 and 9 above need be taken into account only, seeing that, as already pointed out, when bar windings are employed, the two classes of slot are upon the same basis from the remaining points of view.

It will be seen from what has now been stated that, when everything is taken into account, the balance of advantage undoubtedly rests with the hand wound winding placed in holes or partly closed slots. This winding, which originated in Switzerland about 1890, and which corresponds to the standard practice of the leading Swiss firms at the present day, leaves very little to be desired, and in all probability the former wound coils placed in open slots will ultimately become obsolete, at any rate as far as high pressure plants of importance are concerned. At any rate, this is the conviction of the writer, who has to admit to a gradual change of views in this respect during the last two years. In spite of an extended and wholly satisfactory experience with all sorts of hole-wound armatures built for operation at the highest pressures, the apparent advantages of the former wound armature winding, from the points of view of reduced cost of production, facility of repair, and general convenience, caused the writer to take it up. It has, however, not shown any material advantages over the older winding, and on the other hand, experience and close observation has brought to light some of the serious disadvantages referred to above.

A. C. Eborall

THE THEORY OF ALTERNATORS.—V.

By ALFRED HAY, D.Sc., M.I.E.E., etc.

(Continued from page 356).

THE second important application of alternator theory is to the testing of the finished machine. It would in many cases be extremely difficult and costly, if not impossible, to test a large alternator under the specified conditions of load before it is allowed to leave the works. Any method, therefore, which enables us to form a more or less accurate estimate of the probable behaviour of the machine without the necessity of carrying out tests which involve a large amount of power, would be considered extremely valuable. Such methods are furnished by theory. Unfortunately, the complexity of the problem is such that no absolutely reliable and generally applicable methods are available. Sufficient experimental data have, however, been accumulated to show in how far the results furnished by the various approximate methods may be relied upon, and to indicate whether the true result is likely to exceed or fall short of the theoretical one.

OPEN-CIRCUIT AND SHORT-CIRCUIT CHARACTERISTICS, AND THEIR PRE-DETERMINATION.

In both the design and the testing of alternators, two curves are of prime importance. One of these, known as the *open-circuit characteristic*, connects the exciting current with the open-circuit E.M.F. The other, known as the *short-circuit characteristic*, connects the exciting current with the current in the short-circuited armature. Typical forms of these curves are shown in Fig. 15.

The pre-determination of the open-circuit characteristic does not, as a rule, present much difficulty. Values of the field leakage coefficient have been tabulated for various types of machine, and from these and the known dimensions and magnetic properties of the materials forming the magnetic circuit, the exciting current corresponding to a given total flux N entering (or leaving) the armature from each pole-piece may be calculated. If n = revs. per sec., p = number of pairs of pole-pieces, and C = total number of conductors in each phase connected in series, then the R.M.S. value of the open-circuit E.M.F. is given by $K . 2p N n C . 10^{-8}$, where K is a coefficient whose value depends on the ratio $\frac{\text{pole-width}}{\text{pole-pitch}}$, and the nature of the winding. The values of K for various cases have been tabulated.*

The pre-determination of the short-circuit curve is, however, a problem of a much higher order of difficulty. It is generally assumed that in a short-circuited machine the current is in quadrature with the open-circuit E.M.F. On this assumption (which, however, is hardly legitimate in every case) the armature cross-field disappears, and we have to consider the leakage field and the back-field only. It is simpler to calculate these separately rather than to consider their joint effect.

The calculation of the leakage self-inductance is a complicated and more or less uncertain matter; the most important contributions to this subject are those due to Niethammer, la Cour† and Hawkins.‡

As regards the back-field, the problem resolves itself into the determination of the back-ampère-turns of the armature, and the classical method of dealing with this problem is as follows: The armature fusion field due to any one phase, is an alternating one, and is carried round relatively to the impressed field. We may suppose this alternating field replaced by two rotating fields which rotate *relatively to the armature* with equal angular speeds but in opposite directions, the magnitude of each field being equal to half the amplitude of the alternating field. It will be evident from this that one of the component fields, although rotating relatively to the armature, will be *fixed relatively to the impressed field*, while the other will rotate relatively to it with a velocity which is double its angular velocity relatively to the armature. This second component field is

---

* See, for example, Hawkins and Wallis, *The Dynamo* (3rd Ed.), p. 749.

† See *Elektrotechnische Zeitschrift*, vol. 22, pp. 475 and 553.

‡ See *Electrical World and Engineer* of New York, vol. 42, p. 798.

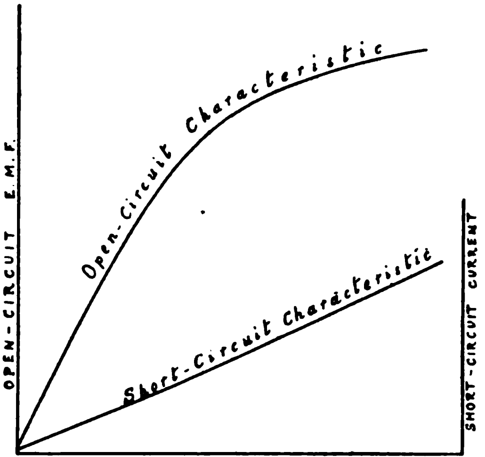


FIG. 15.

then assumed to be rendered negligible by the damping effect of eddy currents induced by it in the solid portions of the field-magnet, so that the only component which need be considered is the one fixed relatively to the field magnet. This latter component —if the short-circuit current be assumed to be in quadrature with the open-circuit E.M.F., will be directly opposed to the impressed field. Let I_a be the R.M.S. value of the armature current, and S = number of turns per pole per phase. Assuming the current to follow the sine law, the maximum ampère-turns per pole per phase are given by $SI_a\sqrt{2}$, and by the above reasoning the back-ampère-turns per pole per phase are $\frac{1}{2}SI_a\sqrt{2}$. If there are m phases, the total back-turns *per pole* are $\frac{m}{2}SI_a\sqrt{2}$, or the total back-turns per magnetic circuit are $m\,SI_a\sqrt{2}$.

The leakage self-inductance per phase l_s having been previously calculated, the leakage E.M.F. is given by $l_s p I_a$. By reference to the calculated open-circuit characteristic, we find the ampère-turns required to provide an E.M.F. $= l_s p I_a$. If to this number of ampère-turns be added those required to balance the total back-turns* of the armature, we get the total field-ampère-turns required to produce the short-circuit current I_a in all the phases. We are thus able to pre-determine the short-circuit characteristic.

It should be pointed out, however, that the comparatively simple formula given above for the armature back-turns gives in most cases values which are much too low (sometimes as much as 50% too low), and it is in any case safer to add, say, 30% to the calculated value. The armature back-turns depend to some extent on the way in which the winding is distributed, and formulae have been deduced which take into account the arrangement of the winding.

The experimental determination of the open-circuit and short-circuit curves presents no difficulty. It is, however, in general impossible to obtain the short-circuit current corresponding to normal excitation, as this current would be beyond the safe limit; values up to about 3 times the normal full-load current may be obtained if the short-circuit is of short duration. In order to find higher values, the short-circuit curve is produced beyond the last point determined experimentally, and further values are thus obtained by "graphical extrapolation."

USES OF OPEN-CIRCUIT AND SHORT-CIRCUIT CHARACTERISTICS.

The importance of the two characteristics whose pre-determination we have just considered lies in the fact that they enable us to form some estimate of the regulating qualities of the machine when excited with a constant current. We shall now give an account of the more important methods which have been proposed for pre-determinating the regulation of the machine—in other words, its *load characteristic* (or curve connecting armature current with P.D.)—from its open-circuit and short-circuit characteristics.

BEHN-ESCHENBURG'S METHOD.

The simple analytical and graphical theory explained in connection with our ideal alternator has been used, without any modification, by all the earlier writers on the subject, and among those who have made important contributions to our knowledge of the subject by the use of this theory may be mentioned, J. Hopkinson, P. Boucherot, A. Blondel, G. Kapp, H. Görges, and C. Steinmetz. By all such writers the term "self-induction" is used in the sense in which we have used it, and not in the sense of "leakage inductance." The theory has frequently been called the "self-induction" theory, because it assumes that the behaviour of an alternaror may be explained by attributing to its armature a definite constant inductance. We shall now point out some of the numerous limitations and short-comings of this simple theory.

---

* *i.e.*, the sum of the back-turns due to all the phases.

It assumes that the armature possesses a constant inductance. So far from this being the case, the inductance of the armature varies with its position relatively to the field, and its mean value further depends on (*a*) the field current; (*b*) the armature current; (*c*) the phase relation of the armature current to the open-circuit E.M.F. To a minor extent, its value is also influenced by the resistance of the field circuit.

The theory further assumes that the armature possesses a definite constant resistance; but the resistance is, like the inductance, dependent on the phase-relation of the current to the open-circuit E.M.F. The effective resistance is in any case considerably in excess of the resistance as obtained by continuous-current measurements. This is due to the fact that the solid portions of the machine, the field winding and the damping coils (if present) all act as closed secondaries of a transformer with respect to the armature winding considered as a primary. We should in most cases be safe to take the effective value of the resistance as from 1·5 to 2 times the resistance measured with steady currents.

The terms "synchronous impedance" and "synchronous reactance" have been applied by Steinmetz to the equivalent constant values of the impedance and reactance which, in the theory under consideration, are assumed to replace the constantly varying impedance and reactance of the armature.

In order to take into account the variation of the mean value of the armature impedance with exciting current, Behn-Eschenburg obtains this value from the open-circuit and short-circuit characteristics, as follows: From the open-circuit curve, the open-circuit E.M.F. corresponding to the given exciting current is obtained; the quotient of this E.M.F. by the short-circuit current corresponding to the same excitation, and obtained from the short-circuit characteristic, gives the armature impedance for that excitation. The impedance may be split up into resistance and reactance, and the values so obtained are used in carrying out the construction shown in Fig. 11, which enables us, by assuming different values of armature current, to construct the load characteristic.

(To be continued).

Alfred Hay

The value of *The Electrical Magazine* can only be tested by giving it a trial. Although it has but just been launched, it has already become indispensable to many Electrical Engineers, who have, in addition, put on record their appreciation of its merits. It was once thought that there was no place in contemporaneous technical literature yet left to fill, but *The Electrical Magazine* has filled it, and what is more, will continue to fill it. The many valuable features characterising its contents will be made still more so as time goes on, but it is to *your* interest to secure it *now*. You are not up to date if this journal is missing from your desk or bookshelf.

ELECTRICITY APPLIED TO MINING AND METALLURGY.

IV. Electrical Machinery in Steel Works.

By PERCY R. ALLEN, A.M.I.C.E.

(*Continued from page 363*)

The blast furnaces may be and often are some little distance from the steel works and the rolling mills. At Ilseder-Hutte the furnaces are between four and five miles away from the Peine rolling mills, and at Hoerde the blast furnaces are on one side of the town of Dortmund, and the steel works on the other, but of course the distance apart must not be so great as to prevent the metal being carried while still molten. The transmission lines are usually naked overhead conductors, protected by the usual regulation network below, when the lines cross a railway or a road. At Ilseder-Hutte, two 3-phase circuits of 10,000 volts are worked in this way without any trouble. At Ougree, near Liege, where the transmission is by continuous current at 500 volts, rectangular aluminium conductors are used with a view to lightness, the total cost of the lines coming out about the same as if copper conductors had been employed.

Of late years, electric travelling cranes for unloading and handling the ore have come into very general use on the Continent. These are mostly long span gantry cranes, commanding the barge or the railway line, the stock heap and the track leading to the blast furnaces. In many of the old installations of blast furnaces, the materials are lifted to the top by means of the old inclined planes, or in some cases by primitive hoists of much the same design as those to be seen about Middlesborough, but in the newer furnaces electric hoists are generally installed. Fig. 1 illustrates a blast furnace lately erected at Cette, on the Mediterranean, by the famous firm of Schneider, of Creusot. It will be seen that a lifting crab runs on a gantry extending right over the tracks on which run the small wagons containing the charge, which is in the proportion of four wagons of coke to five of mineral. The hoisting gear is placed in the vertical pillar at the end, and is driven by a continuous current motor taking 120 ampères at 500 volts, and will raise from 700 to 750 tons of material in 24 hours. This furnace at Cette is of very fine modern design. Owing to the difficulty of getting good surface water the blast tuyeres are cooled with sea water circulated by means of pumps driven by electric motors. The charging bells in this furnace are worked by hydraulic power, but in some of the German furnaces electric motors are now used for this purpose, and Fig. 2 shows an arrangement built by the Junkerather Maschinenfabrik, in which two motors are used, one working the top and the other the bottom cone. Large multiple electro magnets for picking the pigs up from the pig beds are used in

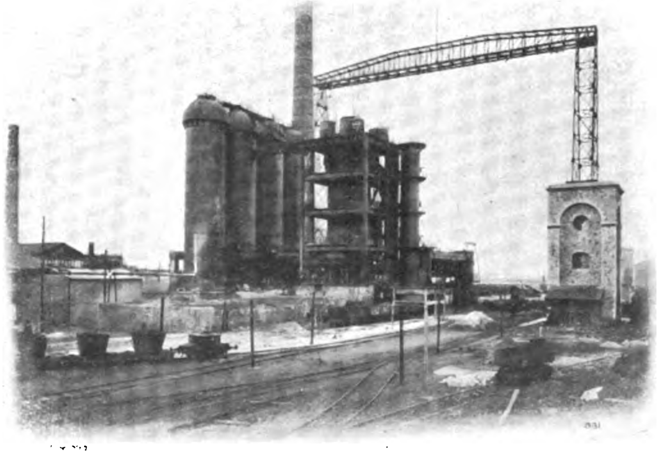


FIG. 1. CETTE BLAST FURNACES.

America, but the writer is not aware of their employment on the Continent. When pig iron casting machines have been installed these are conveniently operated by motors, and where coke oven plant is worked in conjunction with the furnaces, the stamping machines and coke rams are motor driven, but the electrical arrangements do not call for any special comment. From the blast furnaces the hot melted metal is taken direct to the mixer. Electric locomotives are now generally employed to haul the ladle cars, and Fig. 3 shows one made by Messrs. Siemens & Halske, for the Rheinsche-Stahlwerke, Meiderich, near Ruhrort. Where overhead trolley wire transmission is employed, double circuits and double contacts are very generally used to collect the current, and obviate the necessity of an earth return, but in some steel works, accumulator locomotives are preferred as being self contained. Fig. 4 shows a rather interesting electric locomotive built by the Compagnie Internationale d'Electricite, of Liege, for the Ougree Steel Works. The locomotive is only required to have a limited range of action round and about the casting pit, but as the situation made it desirable not to have any naked wires about, the positive and negative conductors are well insulated and then combined in the form of a flexible cable, one end of which is connected with the motor terminals on the locomotive, while the other end is taken to a drum overhead where the conductors are electrically connected to the ordinary circuit by means of slip rings and rubbing contacts. A counter weight attached to the drum tends to keep the cable always taut, the cable unwinding from the drum as the locomotive travels away, the effect being that whatever the position of the locomotive may be, the cable leads direct to the drum, without leaving any slack. The device answers admirably, and the arrangement might be conveniently used in many other situations.

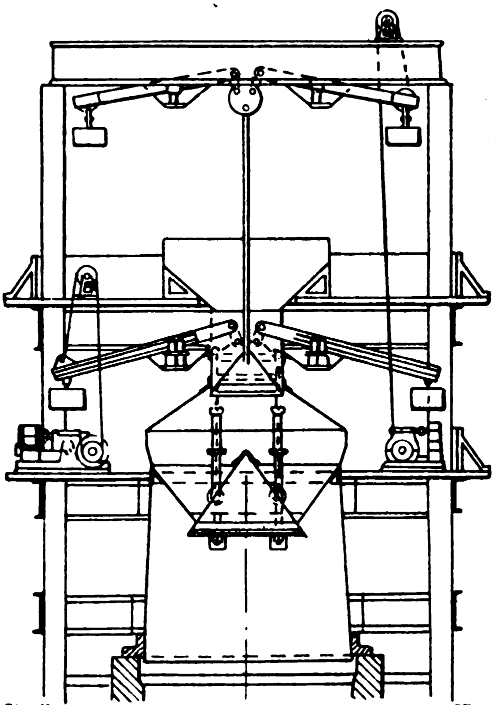


FIG. 2. METHOD FOR ELECTRICAL OPERATION OF FURNACE BELLS.

The delivery of the metal to the mixer may be considered as the point where operations start in a steel works. The function of the mixer is to receive, hold and equalise the mixture of successive runnings from the blast furnaces, and to act as a reservoir to supply the converters and melting furnaces. The mixer is generally a large vessel of semi-hemispherical section having a spout on one or both sides, and capable of being partially tilted for filling and running off, and for removing the slag. Of recent years, these mixers have been built of large capacity, and one lately installed at Dorman, Long & Co., Ltd., Middlesbrough, holds 300 tons. The writer is not aware that electric motors have up to now been applied either to tilting the mixer or to working Bessemer converters, the steel works engineer, when dealing with such large quantities of molten metal, preferring to rely on the positive control of a direct acting hydraulic cylinder rather than electricity, which he still regards as a somewhat fickle, though convenient, source of power.

For some purposes, such as working the bloom shears or ingot strippers, where the operation is intermittent, but requires considerable power at the moment of action, the combination of a hydraulic cylinder with a steam intensifier makes a comparatively simple arrangement, and has a range of power it would be difficult to reproduce with electric driving, except with an ex-

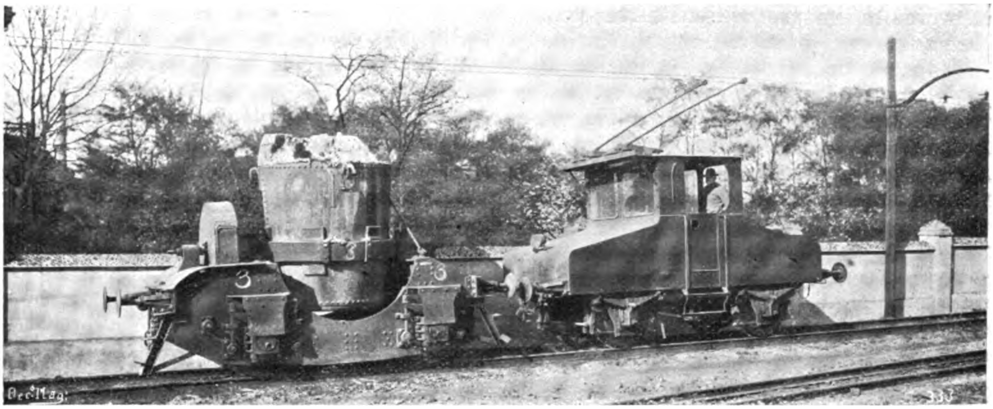


FIG. 3. ELECTRIC LOCOMOTIVE HAULING LADLE CAR.

pensive arrangement of accumulators. However, the convenience of being able to take the power from a pair of leads snugly stowed away on the roof principals, instead of having to depend on a leaking system of articulated pipes, is strongly in favour of electric transmission, as against an ordinary hydraulic power system in a steel works.

In some of the latest designs of cranes and charging machines, the pumps are driven by electro motors combined with the machine, while the actual lifting and handling is done by a hydraulic cylinder, thus combing the advantages of both systems. Hydraulic power is also used to a considerable extent for balancing and adjusting heavy rolls, and later on an illustration will be given where steam, hydraulic, and electric power are all combined in one machine.

The general lay out or arrangement of a steel works may be briefly described as follows. Presuming that both Bessemer converters and open hearth furnaces are used, they would probably be arranged in either one line along the same casting pit, or in some cases on opposite sides. The metal is brought in ladles from the mixer by electric overhead cranes to the converters or to the open hearth furnace if they are fed with hot metal, or if they are charged with scrap, by electric charging machines working at the back.

In many of the new works the radial arrangement of the ingot moulds round a central ladle crane has been given up, and they are placed in lines parallel with the furnaces or converters and filled by ladles either manipulated by overhead travellers or by electric locomotives working in the pit. As soon as the ingots are set, the moulds are lifted off, and in obstinate cases where the ingot clings to the mould it is forcibly pushed out by a stripper which is now sometimes operated by electricity, although hydraulic ingot strippers are still in very general use. As soon as the ingots are free, they are removed as quickly as possible to the soaking pits, where they remain until the heat from the interior has penetrated to the outside, and when this is accomplished they are lifted out, and

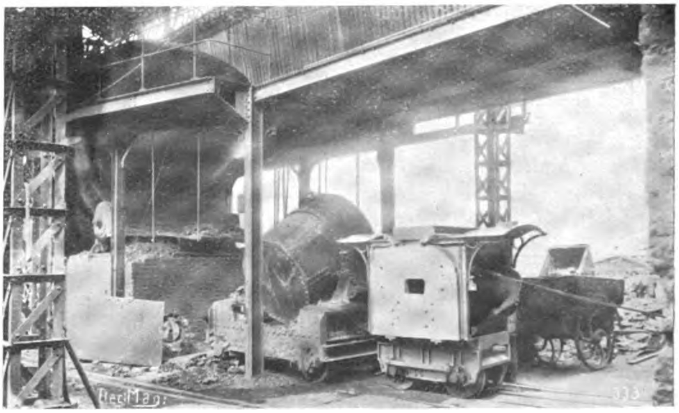


FIG. 4. ELECTRIC LOCOMOTIVE FOR CASTING PIT.
(Note flexible cable on the right).

delivered to the train of live rolls leading to the cogging or breaking down rolls where the tapered ingot is reduced to an elongated bloom or billet by being passed through the rolls in alternate directions. After the required dimensions are attained, the bloom is delivered to another set of live rolls at the back of the mill, and is propelled forward till it reaches the bloom shears, where the ragged ends are sheared off, leaving it square, and it is then dragged sideways by means of skid chains projecting through slits in the floor until it comes over another set of live rolls, which may direct it to one of the finishing trains, or conduct it to the charging machine serving the reheating furnace.

In some mills it is the practice to finish the section at one heat, but reheating, or wash heating as it is termed in the north of England, is very universally employed. The blooms are put into and taken out of the reheating furnaces as far as possible in regular rotation, the same machine serving both purposes, and delivering the reheated bloom or billets to live rolls leading to the particular train of finishing rolls it may be intended for. When the desired section has been obtained, it is again moved on by other live rolls until it comes opposite the hot saws by which it is roughly cut to approximate lengths, after which it is conveyed sideways by a system of skid chains to the hot banks which generally consist of an open structure of railway metals allowing free access of air all round. When cold the finished section is conveyed to the cold straightening presses, and cold saws or cold shears, where it is finished to dead lengths, and is then ready for shipment or for transfer to the stockyard.

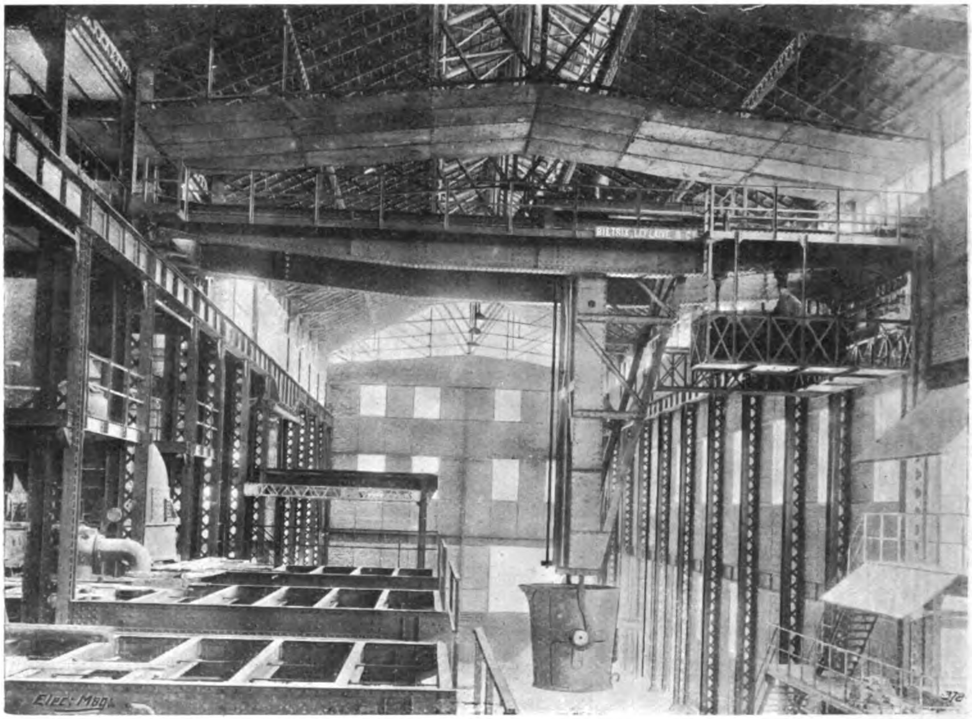


Fig. 5. Special Electric Crane, with Gear-driven Movements for Operating the Ladle.

The foregoing description is only a brief sketch of the general procedure in a steel works rolling structural sections from ingots say up to five tons, and of course the exact lay out of the works depends on local circumstances and the general nature of the business, a mill rolling armour plates naturally differing from one producing bedstead iron or nail rods. Coming back to the crane over the casting pit, and the melting furnaces, it has already been pointed out that security of control and absence of any swaying motion are absolutely essential in dealing with a ladle full of melted metal slung high up in the air, and recently several of the Continental crane makers have met the requirements of the case by using electric overhead travellers in which the actual lifting and lowering of the ladle is controlled by screws extending downwards from the carriage on the gantry of the crane, the ladle being suspended from a crosshead working in guides attached to the crab, and having a nut at each end engaging with the screws, the tilting motion being also controlled by a positive gear from above. A very fine crane on this principle was put up by the Benrather Machine Co., of Dusseldorf, at Differdingen, in Luxemburg, a year or two ago, and another recently at the Neuves Maisons works, of the Compagnie des Forges de Chatillon, Commentry, the crane being by Bietrix Leflaive and Co., and the electrical arrangements being supplied by the French Westinghouse Co. This is illustrated in Fig. 5.

The arrangement in this case is very convenient, as the traveller takes the metal as it comes from the blast furnace, conveys it to the mixer, receives it again from the mixer, delivers it to the Bessemer converters, and afterwards takes it from the converters to fill the ingot moulds, ultimately removing the ingots from the casting pits. In this case everything is worked from above with great advantage in point of view of unrestricted observation and freedom from danger in the casting pit. However, in some works it is still preferred to use locomotive casting ladles working on the floor of the pit, and Fig. 6 shows a combined electric and hydraulic casting ladle being built by Messrs. Kolben, of Prague, and in use at the Kladno Steel Works.

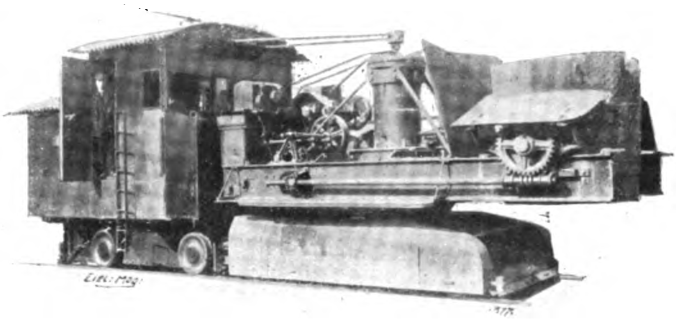


Fig. 6. Electrc-Hydraulic Locomotive Ladle.

In this a very interesting design of alternating current motors are used working at 500 volts, with a periodicity of 25 per second, and while electro motors are used to propel the ladle carriage, and to slew and tilt the ladle, the lifting of the ladle with the charge (in this case 13 tons) is accomplished by a hydraulic ram, worked by a 3-throw pump, driven by another motor at the back of the ladle carriage. This is one of the happy combinations of the mobility of electric transmission with the security of hydraulic power, which has already been referred to, and it is a great improvement over the old smoking, snorting steam locomotive found formerly in the casting pits. As soon as the ingots can be removed from the moulds, they are run round as quickly as possible to the soaking pits which are generally spanned by two electric travellers, one to deal with the ingots themselves, and the other, a smaller and lighter one, to lift the lids on and off, but the electrical features of these cranes do not call for particular remark.

The ingot, when uniformly heated, is lifted from the soaking pit, and delivered into a kind of tilting cage, which turns over and presents it squarely to the set of live rolls leading to the cogging mill. These live rolls play a prominent part in the economy of a steel works; formerly it was the practice to drive them by fast and loose pulleys and belt transmission, but during the last few years all the larger mills have been converted to electric driving. The conditions of working are somewhat analogous to those found in electric traction work, and have been met in a similar manner. It is desirable to have a considerable range of acceleration, but at the same time they may have to be reversed perhaps 2c times a minnte, starting again on full load. Fig. 7 shows a set of live rolls leading to a two-high finishing mill at the works of the Union Co., Dortmund, the installation being made by the firm of Haniel & Lueg, of Dusseldorf. The tops of the rolls will be seen just projecting from the floor, and the motor itself will be noticed on the right hand side of the picture.

The motors may be placed either parallel to or at right angles to the axis of the rolls, and it is frequently advisable to divide up the series of rolls into small groups and drive each section by means of a separate motor or pair of motors arranged with series parallel control as in tramway practice. Fig. 8 shows an arrangement of this kind made by the Junkerather Gewerkschaft, of Junkerath, Rheinland: in this combination an automatic arrangement is applied to change the connections when the rolls obtain full speed, and either motor is powerful enough to drive the rolls alone. Ordinary traction controllers are used for regulating the motors, and when the attendant becomes expert in jerking the current on and off it is wonderful with what precision he can manipulate the passage of the billet, or bar, while it is on the live rolls.

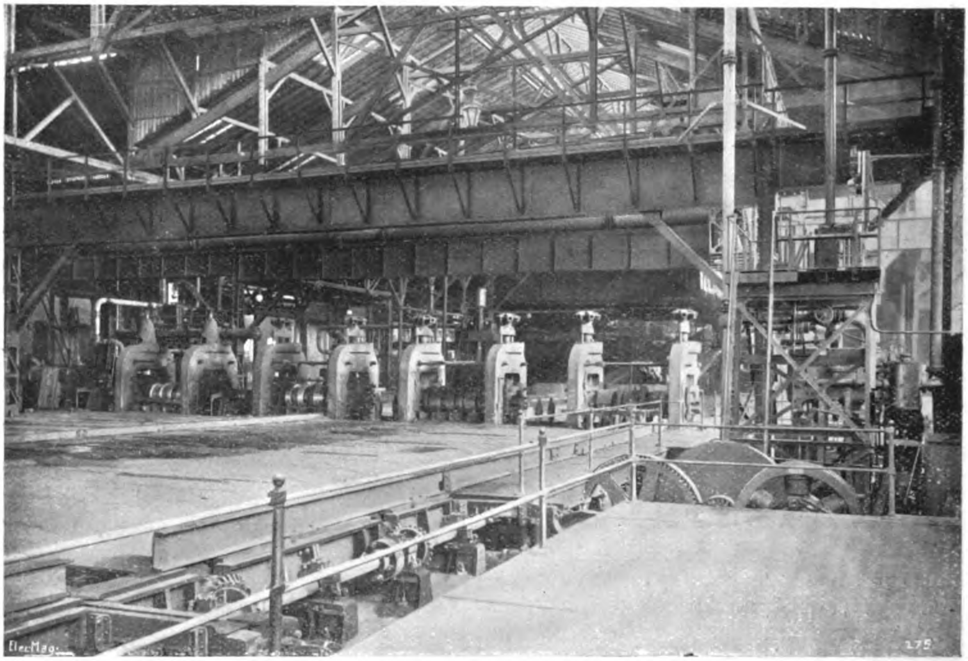


FIG. 7. ELECTRICALLY-DRIVEN TWO-HIGH ROLLS.
(Motor and gearing on right of illustration).

Where the Siemens open hearth furnaces are fed with scrap and not with fluid metal, automatic furnace charging machines are now almost universally used, and electricity is employed as the motive power. In general idea, these resemble the machines in common use for charging gas retorts, and consist of a large scoop fixed at the end of a stout shaft which has a kind of universal movement and can be projected forward into the furnace as soon as the door is opened, and at the same time the scoop is capable of being partially rotated with the shaft. Sometimes the machine is arranged to run on the floor in front of the range of furnaces as shown in Fig. 9, which illustrates a machine built by the Benrather Maschinenfabrik, for the steel works of Thyssen & Co., Mulheim (Ruhr), but in other cases the machine is suspended from an overhead gantry in the roof. The action of the machine is as follows: The scrap and anything else that goes to make up the charge is placed in the scoop, and the machine is then moved along until it is opposite the furnace, the door of which is then opened, and the scoop with its contents is run out quickly into the furnace, when it turns over and deposits the charge at the desired spot; the introduction of this kind of furnace charging machine has been attended with great benefit, both in the saving of time and from a humanitarian point of view, and electric transmission is exceedingly convenient for this purpose.

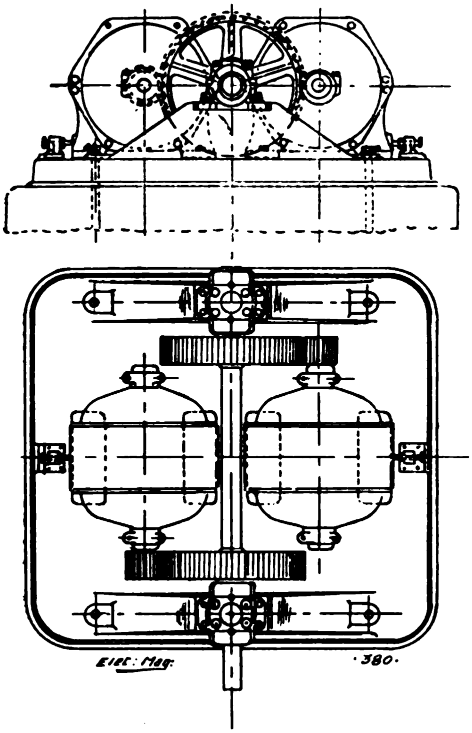


Fig. 8. Motors Arranged in Pairs for Driving Rolls.

Ingots of moderate size, say up to five tons, intended to be rolled into joists or similar sections are sent to the cogging mill as they leave the ingot moulds, but where large ingots are produced such as are used for gun forging, propeller shafts and the like, and which may weigh from 50 to 60 tons, the top of the ingot has to be cut off before further treatment.

At the works of Haniel and Lueg, Dusseldorf-Grafenberg, three very large electric driven machines are used for this purpose, the cutters which are circular saws, being driven by motors on a radial arm. It may be mentioned, however, that this source of waste has been considerably reduced by the system of gas heating the top of the ingot while it is setting, a plan patented by Herr Reimer, one of the chief engineers of the firm of Haniel & Lueg. Before proceeding with the consideration of electricity for driving the train rolls themselves, it may be best to describe a modern electric traveller used far changing the rolls. With a view to minimise the time required, it is now the practice in some of the German works to change the rolls with the housings, all complete, so that, as one set of rolls is taken out, another set, which has already been fitted up in interchangeable housings, is ready to be dropped into position and

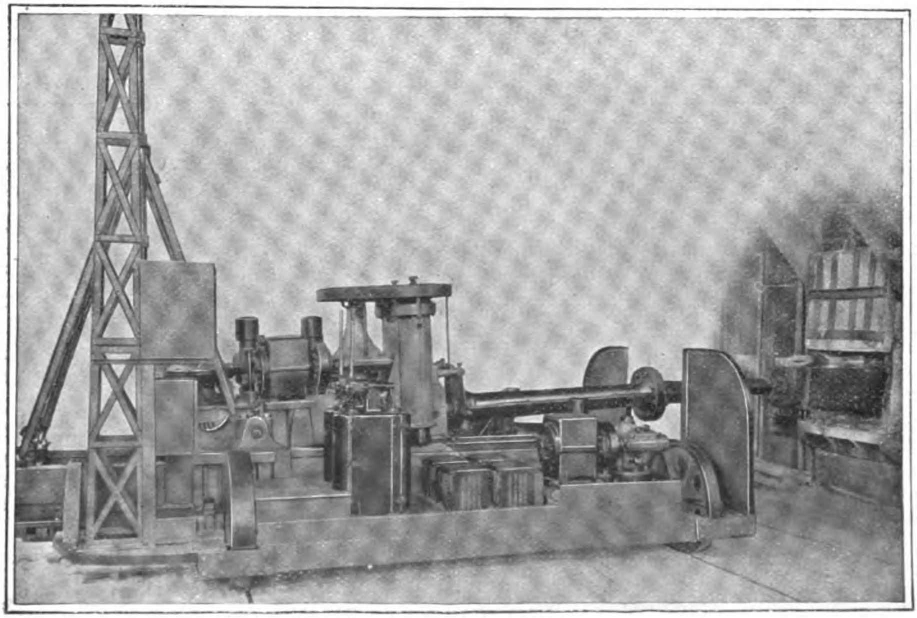


Fig. 9. Electric Charging Machine for Floor Service.

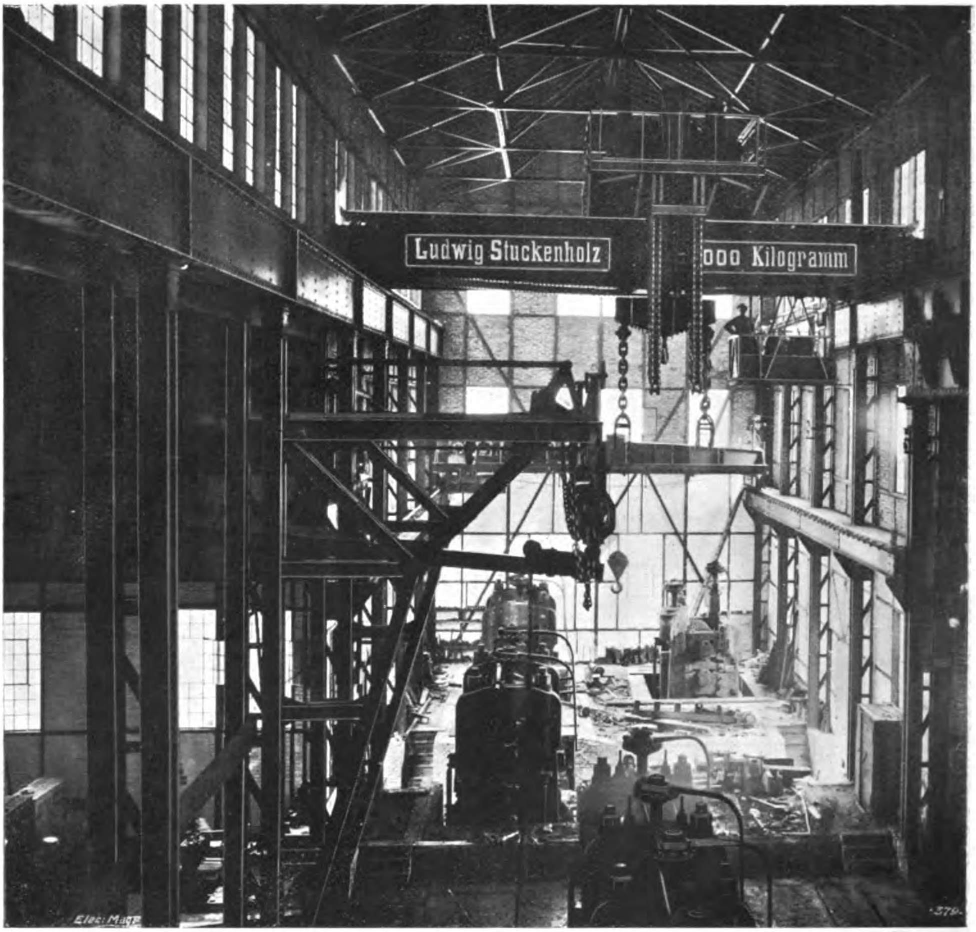


FIG. 10. OVERHEAD ELECTRIC CRANE FOR CHANGING ROLLS AND HOUSINGS.

coupled up direct. Fig. 10 shows an electric traveller built for the Rheinische Steel Works in Meiderich bei Ruhrort, by the firm of Ludwig Stuckenholz, of Wetter on the Ruhr, the electrical arrangements being supplied by Siemens & Halske.

This is a very powerful machine capable of lifting 150 metric tons, and was tested up to 200 tons. Three motors are used, and the lifting gear is of a somewhat novel design. The load is suspended by four chains attached to a swivelling crosshead, which, in its turn, is hung from a block containing two pulleys round which work two heavy pitch chains attached to an equalising bar on the crab, the free ends passing over two sprocket wheels on the same shaft, which is driven through a heavy train of gearing, ending with a worm on the motor shaft, which runs at 600 revs. per minute. As it would be inconvenient to have the slack ends of the chain dropping down on the work being lifted, the crab is turned sideways, and as the chain comes off the sprocket wheels it packs itself neatly away on an inclined plane, as it were folding itself up into short loops outside the crane girders. Despite the massive nature of the gearing, all the movements take place at a high rate of speed, and the writer was informed that it only took an hour and a half to change the entire combination of a set of rolls.

(To be continued).

Percy R Allen

POWER: and·its·application·to· INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

Electric Power in Printing.

The "Holmes Clatworthy" System.

By the ASSOCIATE EDITOR.

RELIANCE solely on electric power for printing newspapers and illustrated weeklies of high quality is now becoming more and more common, and although a few well-known dailies are dependent on steam the list of houses employing the motor drive leaves comparatively few large concerns outside its columns. A few short years ago so complete a revolution to new and untried methods could hardly have been prophesied; yet, to-day, the work of conversion has proceeded so rapidly and upon such sound lines, that one firm at least can point to a magnificent record of 4,400 h.p. in motors supplied for printing purposes. To search for the cause of such a revolution in printing machine operation would be merely to emphasise the inadequacy of steam or gas power, and that these methods have not fully met the case goes almost without saying. Chief stress must, however, be laid on the task so successfully accomplished by electrical engineers in adapting motors to machines, whose changes under load conditions presented obstacles difficult to find in almost any other sphere of labour. It is pleasant to put on record the work of a British firm in this connection, as much has been said and heard of foreign methods, which though in no way depreciating, we prefer to meet with counter designs of equal eminence. The "Holmes-Clatworthy" system, exploited so successfully by J. H. Holmes & Co., of Newcastle, has been before the public some 3½ years, and its chief technical features are now well known. We may, however, revert to these as sufficiently interesting to bear further comment. Two motors are employed: one a simple shunt machine, of large power, to work under full load; the other a smaller machine, series wound, and giving about 1-9th

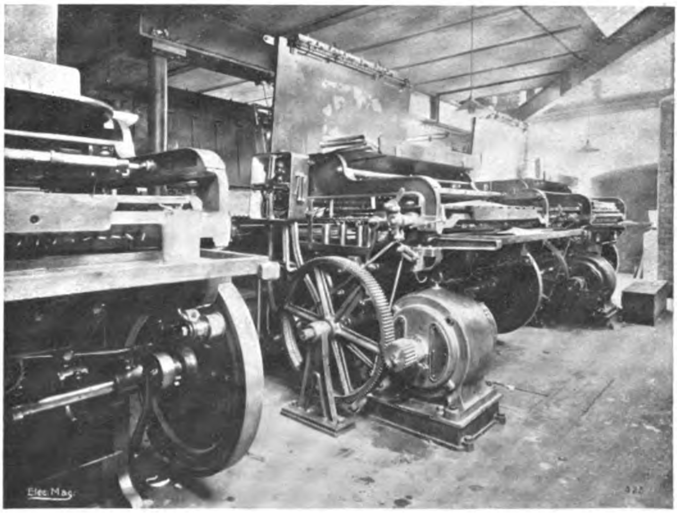


FIG. 2. ELECTRICALLY DRIVEN PRINTING MACHINES. *The Graphic* OFFICES.

or 1-10th the power of the larger motor, and running at a high speed. The motor shafts are coupled together and to the printing machine: in the first instance through worm gearing and a clutch, and in the second by spur or bevel wheels. In Fig. 1 the small motor can be seen at A, and the larger at B, the frame of the rotary press being also clearly visible. The small motor starts the press, the larger motor being idle, though its armature revolves. When the larger motor is needed its circuit is closed, and the claw clutch disengages when the shaft speed exceeds that of the small motor. The clutch, being solenoid controlled from the smaller motor, becomes inoperative when the speed of the latter falls sufficient to de-energise the coil. The small motor can be kept running any length of time, and the entire system is controlled from a central switch box operated by one handle. By revolving this, the small motor is switched in and accelerated, further movement bringing up the large motor, which automatically releases the small one as explained above. Fig. 1 represents a portion of the equipment at *The Daily Graphic* offices, London, where five sets on this system are at work in place of steam. The extreme compactness of the power unit compared with its work is clearly demonstrated, together with the neat method of piping up the conducting cables. In the left-hand corner the controller can be seen. Fig. 2 illustrates one of eight motors installed at *The Graphic* offices, and driven by the Castle motors of the same firm. Plain spur gear is used, with a raw hide pinion on the motor shaft. The field winding of the motors are arranged to compensate for violent load fluctuations, due to the passage of the table under the impressions. Holmes-Page automatic starters are employed, and speed control is effected from an independent rheostat giving twelve speeds from one half to full. To a large extent this is accomplished by weakening the field, so that a part of the range is extremely economical. The presses driven are all flat bed machines, with twin feeder, this feature being clearly discernible in the illustrations. The presses are Messrs. Dawson's "Perceler" type. The controlling switchboard contains the usual instruments

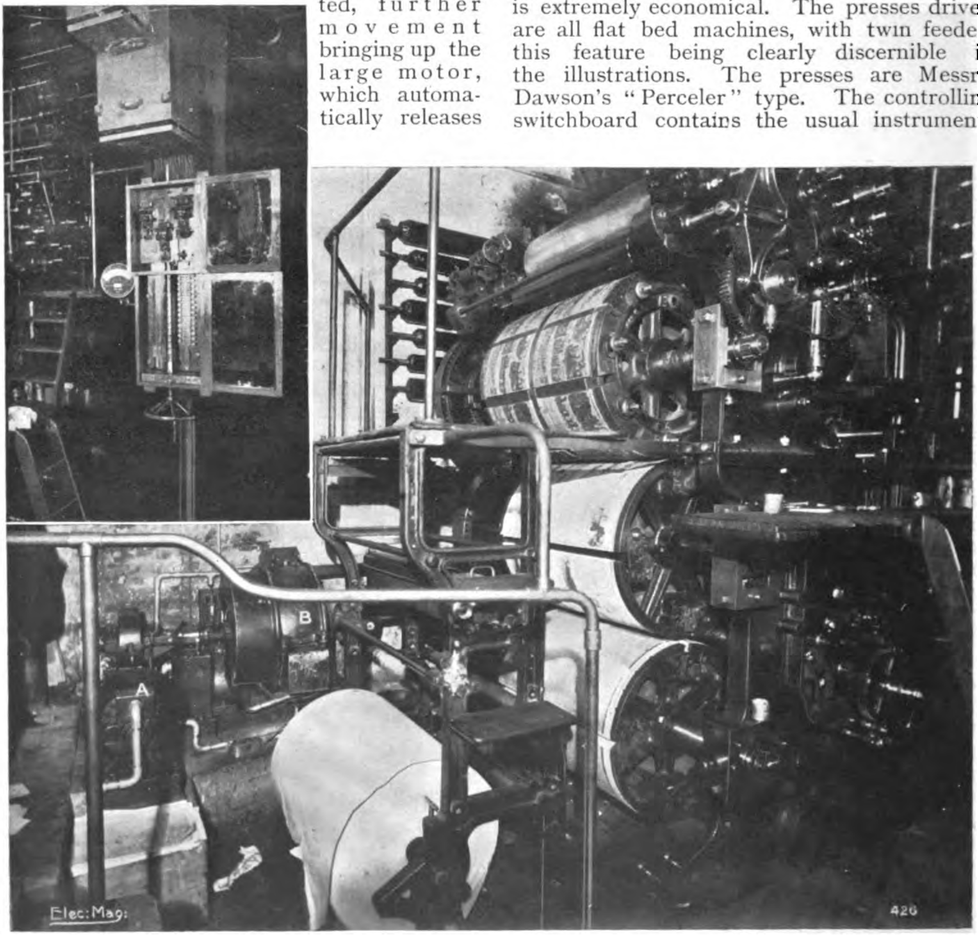
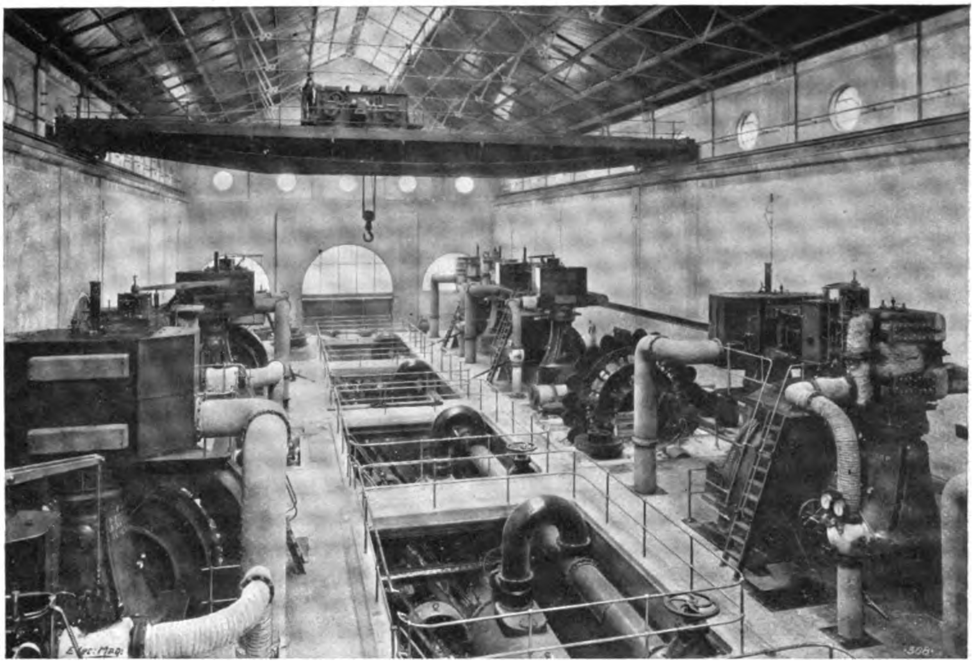


Fig. 1. Holmes-Clatworthy System Applied to Rotary Newspaper Press.
(The left top illustration shows the controller.)



West Ham—Engine Room of New Station.

and switches. In addition to distributing power to the presses mentioned, circuits radiate from it to the other floors, on which are motor driven folding, stitching, and cutting machines.

Space will not permit us to deal further with this system; but we understand from the makers that it has met with unqualified approval. In certain instances it has replaced electrical systems—excellent in themselves, but doubtless lacking that simplicity which characterises the "Holmes-Clatworthy" method. In days when British electrical engineers are frequently taken to task for lethargy and prejudice against innovations, the exploitation of simpler methods to those of outside commercial rivals is worthy of notice, together with the business spirit evinced by directors responsible for the newspapers and publications in whose establishments such methods are introduced.

* * *

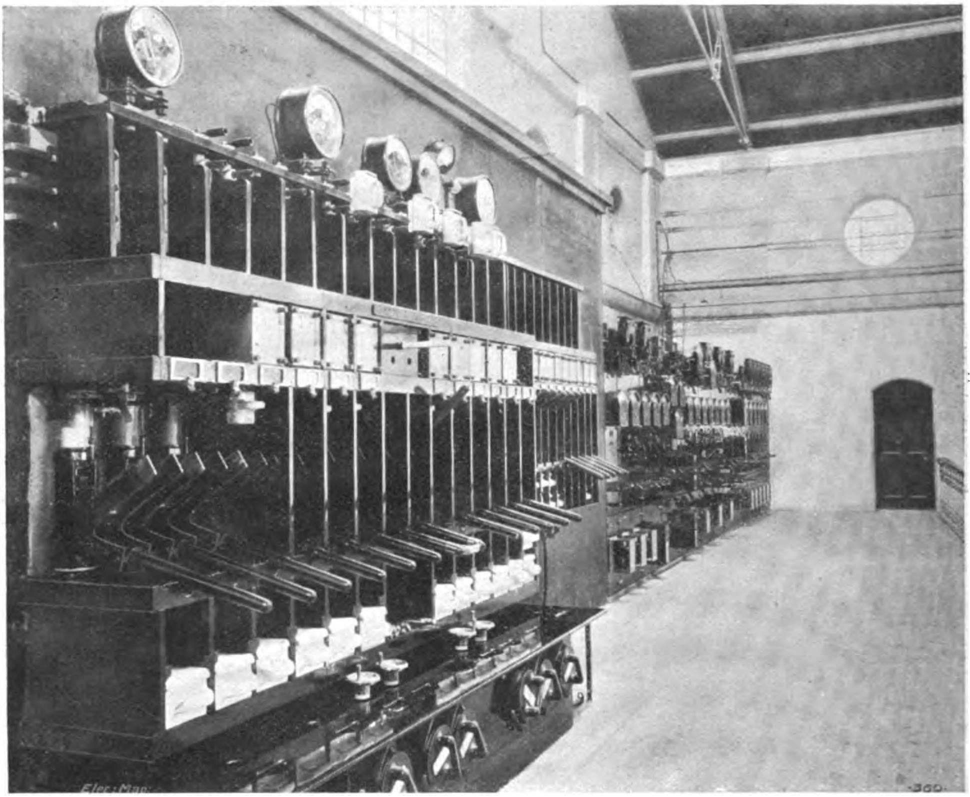
WEST HAM'S NEW POWER HOUSE.

We illustrate this month the engine-room and switchboards at the Canning Town power house of the County Borough of West Ham. This plant, which is supplemented by the Abbey Mills plant also, has been laid down to meet the increasing demand for power and light and also for the supply of the tramways within the Borough, purchased from the North Metropolitan Tramway Co. At present there are installed 2 300 kw. A.C. sets, 2 600 kw. ditto, also 2 1,200 kw. and 3 500 kw. continous current machines. The engines are all by Messrs. Ferranti, Ltd., and the alternators are the same firm's copper type machines generating single phase current at 2,000 volts, 50 periods. The traction sets are by Messrs. D. Bruce, Peebles & Co. and furnish current at the usual 500-550 volts. The engines and generators occupy each side of the engine-room and the condensing plant the centre, this comprising four surface condensers of 4,000 sq. ft. surface, and Edwards' 3-throw air pumps direct driven from the armature of a D.C. 500 volt motor. There are also two condensers of 2,000 sq. ft. cooling surface with steam driven accessories. Steam is furnished by 17 Babcock & Wilcox boilers, at 150 lbs. pressure, 13 boilers being hand fired and the rest by chain grate stokers. The lighting switchboard is of Messrs. Ferranti's usual cellular pattern and the traction gear is by the B.T.H. Co. The whole plant has been arranged to the designs of Mr. J. K. Bock, and to his successor, Mr. W. J. W. Bullock, we are indebted for the photos herewith reproduced.

* * *

ELECTRIC POWER IN SUNDERLAND.

The activity at present displayed in power circles in the North-east of England is phenomenal, and it is pleasant to record the enterprise of a go-ahead municipality among the specially active parties concerned. The corporation of Sunderland electricity scheme during its



WEST HAM—SWITCHBOARD IN NEW POWER HOUSE.

nine years' existence, has developed rapidly from a small direct current station to one of the chief municipal power supply authorities with modern polyphase plant, in the North. Under the able engineership of Mr. J. F.C. Snell this transformation has taken place, and to-day the plant is under contract for power supply to two at least of the largest shipyards in the district. The entire scheme possesses many interesting features but we can only lightly touch upon these, and refer our readers to the illustrations opposite, depicting the chief features of the power-house and sub-stations. At the Hylton-road station there are 3-750 kw. three phase generators by the Electrical Company, driven by Belliss & Morcom's triple expansion engines of 1,100 b.h.p. Three phase current at 5,500 volts is distributed from a central machine and feeder H.T. switchboard, and the four sub-stations at present built. These are at Dunning St., Pallion St., Whickham St. and South Docks, and are fitted with 2-240 kw. motor generators in the first two cases (those at Pallion St. being compound wound) and 2-125 kw. at Whickham St. 3-300 kw. static transformers are installed at the last named sub-station. There are H. and L.T. switchboards in each sub-station, and provision for starting the synchronous motor generators, through induction motors from the direct current bus bars, is made at Pallion St. A battery is installed at Dunning St. for this purpose. The North Eastern Marine Engineering Co., and Messrs. William Doxfords are the chief customers, particulars of their consumption being given in our last issue. We are indebted to the kindness of Mr. A. E. Hadley, of the Electrical Co., for the photographs reproduced herewith, the firm he represents being the contractors for the entire electrical plant. The cause of electric power is likely to obtain many valuable adherents in this district and the consulting engineer, his assistants and the contractors are to be congratulated on the success of the scheme. We shall look forward with interest to its future records.

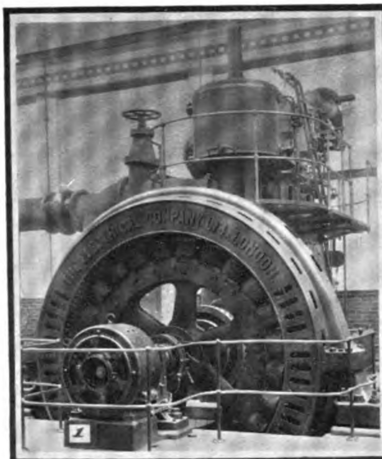
❧

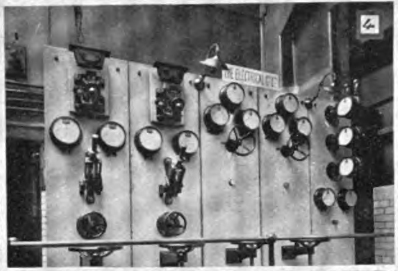
FURTHER INTERESTING STEAM TURBINE INSTALLATIONS.

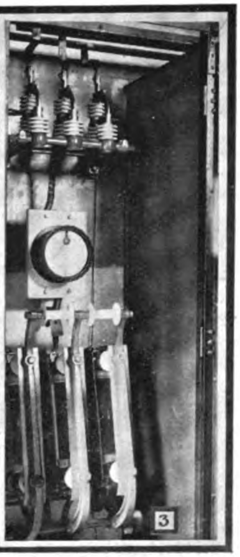
IN a previous issue we remarked on the arrangement of steam turbines in several well known power houses. We are now able to give some further illustrations which will be of considerable interest to our readers.

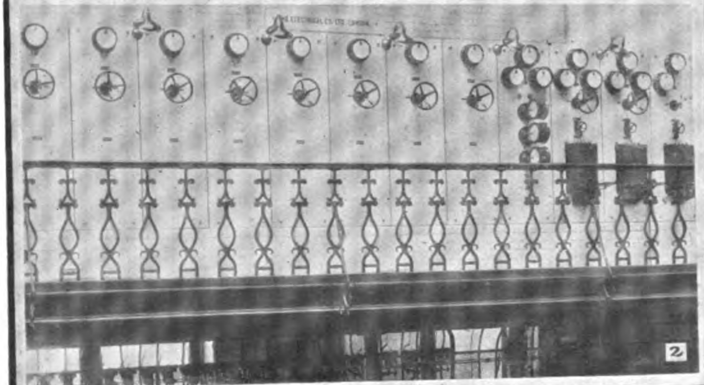
The Zanesville Railway, Light, and Power Co., whose plant has been described in the majority of the technical journals recently, possesses an interesting power house, which supplies a local street railway, an inter-urban line within the city

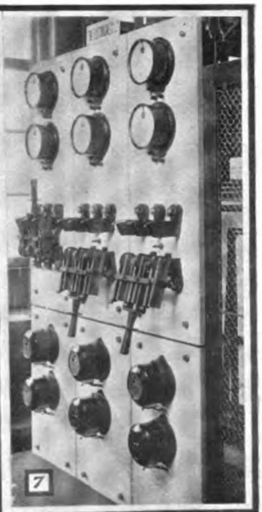
Electric Power in Sunderland.

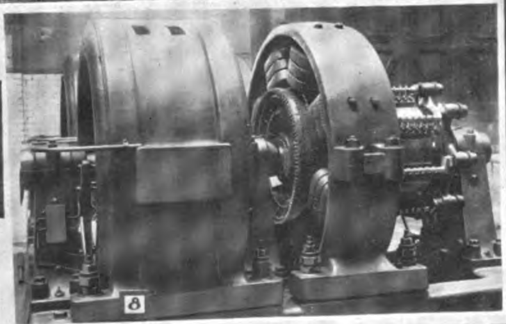


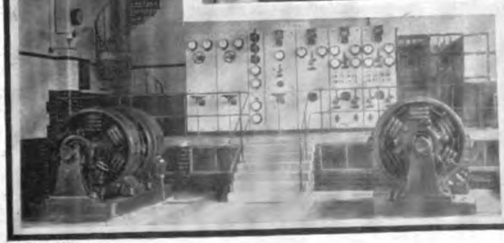


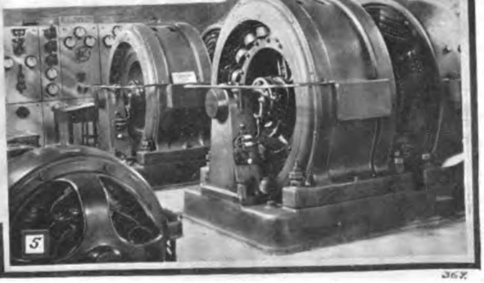












Elec. Mag.

(1) 750 kw. 3-phase Unit. (2) H.T. Station Switchboard. (3) H.T. Fuse Panel. (4) H.T. Sub-station Switchboard (5) Denning St. Sub-station. (6) Whickham St. Sub-station. (7) L.T. Transformer Panels. (8) Motor Generators, Pallion St.

367

limits, a general city lighting system, and electric power for manufacturing purposes. A re-organisation of the company has resulted in a complete re-modelling of the power house, originally driven by steam. A dam has been thrown across the Muskingum River, and from an effective head of 14 ft. some 5 turbine wheels are driven. Fig. 1 illustrates the manner in which these operate a line of shafting, at each end of which two 375 kw. alternators are driven. Each wheel develops 278 h.p. at 200 r.p.m. The line of shafting is divided into three sections, which admits of the running of either alternator by any of the water wheels. Steam plant is also installed, furnishing power to two 500 kw. Curtis vertical turbines. Fig. 2 illustrates the manner in which these have been erected, with their condenser outfit. The generator surmounts the turbine, and the engine room floor has been built up on a level with the ventilating holes in the field core, as shown in Fig. 2. The condensing plant is then arranged in the basement, and in that position is readily accessible. The extremely compact nature of the unit, with its condensing plant, can be gathered from Fig. 2. The basement is 14 ft. above high water level. The turbines operate at 1,800 r.p.m. A special oiling system, comprising an electrically driven oil pump, supplying oil at 300 lbs. pressure to the bearings, is employed. This pressure is necessary to counteract the end thrust on the shaft and to give the necessary clearance. The other electrical features of the plant are of considerable interest, but do not merit any special notice here.

In Fig. 3, the arrangement of a horizontal Curtis turbine is shown, this plant being installed at the Port Huron Electric Light and Power Company's station. A full description of this plant was recently given in *The Electrical World and Engineer*, from which we obtained the illustration and particulars. This station has also been recently re-modelled, and the old steam plant supplemented by a 1,500 kw. turbo-generator as shown. The machine operates at 720 r.p.m., and a surface condenser arranged to the side and below it maintains a vacuum of 28 in. Both electrical and mechanical governors are provided, the latter being for emergencies. It operates the butterfly valve when the speed reaches 800 r.p.m., or 50 revolutions above normal. This emergency valve can also be operated by hand. The electrical governor is ordinarily used, and comprises a magnetic clutch operating it by a series of contacts. The clutch connects the governor shaft with the port valves, and through this closes some of the row of ports when the speed exceeds certain limits, and *vice versa* when a drop in speed is occasioned. The regulation with this governor with traction load varying from 150 to 500 kw. is within 1·4 per cent. This regulation was maintained during recent heavy snow storms, when deep drifts had to be negotiated by the inter-urban cars. The load would vary from zero to 1,500 amps., and this load variation was made without any perceptible change in speed. The current for operating the governor magnets is supplied from the exciter circuit. These illustrations give an excellent idea of the compact manner in which turbine units take up their place in a central station. As compared with many reciprocating plants the examples quoted would occupy very much less space. The combination of the turbine with its condensing plant is well illustrated above, and it is not too much to say that future power plants will be designed very much on these lines.

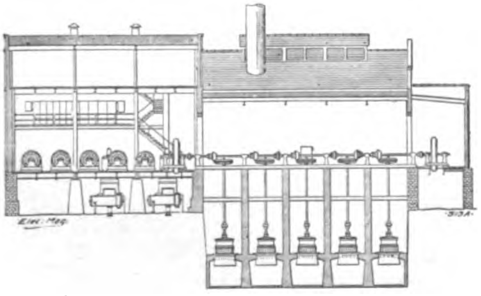


FIG. 1. WATER AND STEAM TURBINES IN A POWER HOUSE.

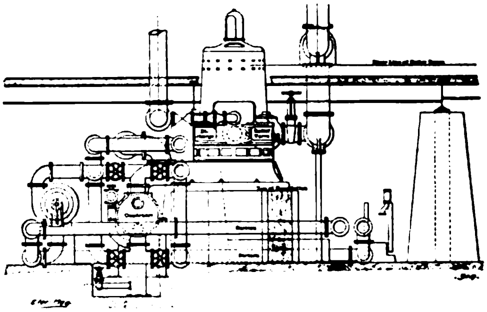


FIG. 2. CURTIS TURBINE WITH CONDENSER BELOW FLOOR.

ELECTRIC GOVERNING OF STEAM TURBINES.

We refer above to the electric governing of the Curtis turbine in Port Huron Power Station, and from the *Western Electrician* take the following particulars, which will doubtless be of interest:—

A simple means of governing a series of steam turbines has been devised by Charles G. Curtis, of New York, which does away with the multiplicity of valves leading to the buckets of each turbine. The controlling element is a centrifugal governor, which may be mounted on or driven from the shaft of the first turbine of the battery, or in case the turbines are driving A.C. generators, this centrifugal governor may be driven by a synchronous motor connected with the bus bars. This centrifugal governor serves to open and close a valve admitting water, oil, or other suitable liquid to opposite ends of a cylinder, in which moves a piston, which by its movement opens and closes directly or indirectly and in proper order the valves controlling the supply of steam to the turbines. The general scheme of the apparatus is clearly shown in Fig. 1, in which 1, 2, 3, 4, and 5, represent turbine units, together with dynamos connected to the bus bars, 8, 9. Magnets 10 and 11 control the valves of the turbines. For simplicity of illustration, only two of such magnets are shown for each turbine, the magnets 10 con-

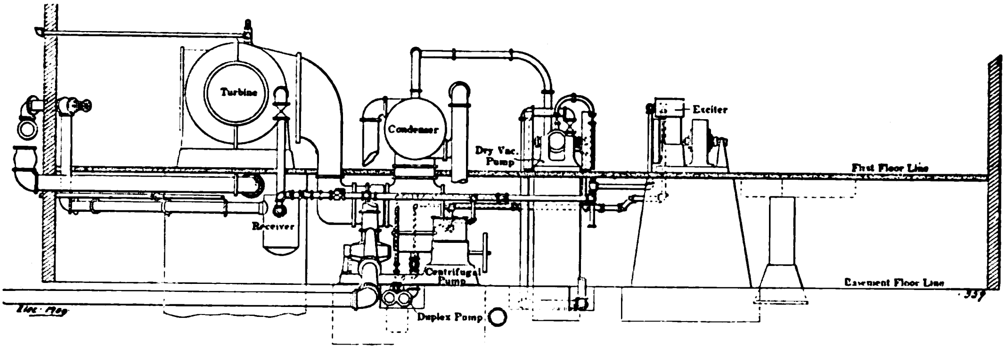


FIG. 3. CURTIS HORIZONTAL TURBINE AND CONDENSING PLANT (p. 486).

trolling the full-load valves, and the magnets 11 controlling the over-load valves. The magnets are connected by separate wires, 12 and 13, with the separately insulated contacts 14, 15, while a return wire 16, common to all the magnets, is connected with a plate 17, and includes a source of direct current 18. A contact plate 19, having a length equal to all of the contacts, slides over the contacts and the plate 17. The contact plate 19 is carried by the rod from the piston which moves in the cylinder. The piston is moved in one direction or the other by liquid under pressure admitted to opposite sides of the cylinder and exhausted through suitable entrance and exhaust ports controlled by a valve 22. The valve is moved by a centrifugal governor, which is driven by a synchronous motor, connected by wires with the bus bars, 8, 9. When the turbines are not running, the throttle valves will be closed and the switches opened, the piston will stand at the left-hand end of the cylinder, and the plate 19 will cover all the contacts 14 to 15. To start up the plant, the circuit to the magnets 10, 11, will be closed, thus opening all the turbine valves controlled by the various branches of that circuit. Steam will then be turned on the first turbine by opening its throttle. When the dynamo operated by the turbine has acquired the proper speed, it will be connected with the bus bars, and the circuit to the synchronous motor will also be closed. The motor will at once acquire the speed of the dynamo and will operate the centrifugal governor, which will move the valve 22, to the right and move the piston to the right until the plate 19, covers the proper number of contacts. Assuming that the throttles of all the turbines are open, and that all the dynamos are connected with the bus bars and are turning, the operation of the governing apparatus will be as follows: Starting with a light load on the first dynamo, it is assumed that plate 19 rests only on the contact 14 at the extreme right, thus opening the full-load valve of the first turbine. As the load is increased the first dynamo will reduce in speed, and this will cause the synchronous motor to reduce in speed, causing the governor to move the valve, 22, to the left, opening the right-hand end of the cylinder to the liquid pressure and the left-hand end of that cylinder to the exhaust. The piston will be moved slowly to the left, drawing the contact plate 19 upon the second contact 14, and opening the full-load valve of the second turbine. This will cause the second turbine and the dynamo driven by it to take a part of the load, and the synchronous motor will regain its speed and move the valve to a central position, covering both pressure ports to the cylinder. As the load further increases, a similar sequence of operations will take place, and the contact plate 19, will be drawn farther to the left, covering in succession the contacts 14, connected with the full-load valves of the third and subsequent turbines. A still further increase of load will cause a continued movement of the contact plate to the left, so that it will cover in succession the contacts 15, and will successively open the overload valves of the several turbines. The reverse operation takes place as the load decreases.

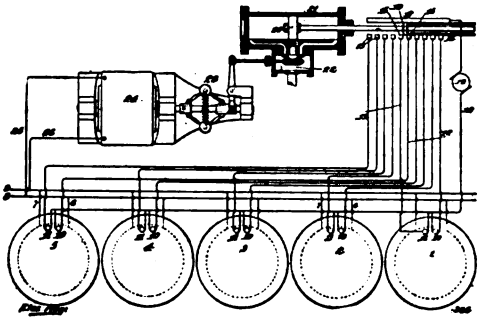


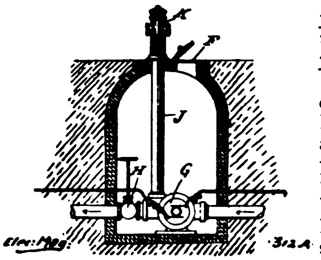
FIG. 1. DIAGRAM OF TURBINE GOVERNORS.

In our next issue we shall describe in this section an interesting water power plant installed in this country. In addition, if space permits, an illustrated account of the application of electric power in small manufactories in France will be included.

The Power section of "The Electrical Magazine" is a comprehensive monthly record of events in power circles. No other electrical journal presents its readers in so complete a form with current power news.

Electric Water Supply System.

THE recent disastrous conflagrations in America have drawn attention to the auxiliary water supply systems of cities built near the sea or great lakes. A salt water system of pipe lines has been advocated, and in New York, practical suggestions have been put forward for employing electricity in conjunction with them. The adjoining cut, taken from the *Electrical Review*, N.Y., illustrates a rotary electric pump inserted in the pipe line and built in a manhole under the street. K is the hydrant, F the manhole cover, J the stand pipe, H the controlling valve, and G the motor. The mains are to be preferably tapped at street intersections and the motors to be controlled from some central supply source. By the use of the valve, the motor would either feed into the continuous series of pipes or into the hydrant. The pump nearest the supply would be set to deliver water into the lines through adjoining pumps and the feed would then be concentrated in a particular spot by the adjustment of the valves. Once these were set going, a practically inexhaustible supply of water would be available. If put into operation the scheme will be watched with considerable interest, as there are many large cities in which the assurance of a handy supply of water during times of fire would well merit the necessary expense of the installation.



* * *

GENERAL POWER NOTES.

* * *

Power Transmission from Amiens to Longueau.

THE Northern Railway Co., of France, is laying down a plant at the Amiens railway station where continuous current, supplied from the station itself, will be converted into monophase and transmitted to Longueau 5 km. off. There will be two Westinghouse converters of 35 K.W. each, transforming direct current at 125 volts into alternate at 88 volts, the frequency being 50. A step-up transformer will raise this pressure to 35,000 volts, which at Longueau will be lowered to 115.

The Est-Lumiere Co., of Paris.

THIS Company supplies power to a great portion of the suburbs east of Paris. The power house is at Alfortville on the Seine, and it was necessary, on account of the close proximity of the river, to build the engine house on piles. There are six batteries of two multitubular boilers each, and the engines, which are tandem-compound, develop from 700 to 1,000 i.h.p. The alternators, of the Alioth rotating field type, have a rated capacity of 540 kilowatts at 5,240 volts, with a cos $\phi = \cdot 75$ or 720 kilowatts apparent capacity, the frequency being 50. Each alternator weighs 58 tons, and is 6·370 m. high, the diameter and weight of the rotating part, which acts as a flywheel, are 5·10 m. and 38 tons respectively. The stator is in four parts. The exciting current is supplied by 75 K.W., 125 volt generators, coupled direct to triphase motors of 100 h.p. at 5,000 volts. A storage battery of 400 a.h. capacity is used at starting to excite the first alternator, which supplies current to the triphase motors of the exciting sets. The switchboard is 14 metres long, the bus bars and connections for each phase being painted a different colour. A flying bridge erected on the river bank supports an electric crane, which is used for unloading coal. Current reaches the different sub-stations through six underground feeders, the voltage being let down from 5,000 to 250 or 110 volts, by Alioth transformers. The total lengths of mains given below afford a good idea of the importance of the plant.

Primary—	Underground feeders ..	44,382 km.
	Distributing cable ..	36,800 ,,
Secondary—	Underground feeders ..	16,312 ,,
	Overhead cable.. ..	228,178 ,,

The cost of the plant is estimated at eight million francs.

Grenoble High Tension Power Scheme.

THE Société de la Romanche has undertaken to supply power to the municipality of Grenoble for lighting and industrial purposes. Triphase current is generated at the Livet power house 35 km. from Grenoble, and transmitted to a sub-station close to the gates of the city, where triphase transformers of the Labour type reduce the voltage from 26,000 to 5,000 volts. These are kept in oil and refrigerated by currents of water flowing through coiled piping. In the secondary switchboard, one part is devoted to the town, and the other to the surburban feeders, there being a separate meter on each phase. The urban network is supplied by three feeders, two only being required for the suburbs, and they are constituted of armoured cable, having three conductors of 5 mm. section. They are buried at ·70 metres under the pavement, 1·60 m. under the roadway. The city transformers will lower the voltage still further to 125 volts; they are placed in street boxes or cylindrical plate iron kiosks, each of which contains a high and low tension switchboard, with the usual fixtures and connections.

Direct Current from A.C. Systems.

IN a paper read before the Dresdener Elektrotechnischer Verein, Mr. Koch (*Elektrotechnischer Zeitchr.*, April 14th, 1904), describes an apparatus designed by himself for deriving direct current from alternating current networks. This apparatus consists mainly of an interrupter working synchronously, and resembling externally a polarised alternating current alarm. The armature oscillates with the alternating current field, opening a contact designed for the passage of large currents with the greatest accuracy when the current reaches its zero value. This is effected by inserting a condenser and a variable self-induction. The author shows, by means of a Braun tube, how the converter influences the alternating current curve, demonstrating by some experiments the use of the converter for charging accumulators and working induction coils.

The extrarodinary and rapid developments in electric traction call for a special section entirely devoted to this work. The main systmes in vogue or projected in every country will be specifically considered, and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

ELECTRIC TRACTION FOR RAILWAYS.

V. *The Oerlikon 1-phase System (Contd.)*

By W. M. MORDEY, M.Inst.C.E., M.I.E.E.

(Continued from page 387).

Since describing this system in a previous article,* the author has seen it working on an experimental line adjoining the works of the Maschinenfabrik Oerlikon, near Zurich. The occasion was a demonstration given in the presence of a number of railway and electrical engineers. It may, therefore, be of interest to refer again to the system and to state the impressions produced by actually seeing it at work.

So far as can be judged from a trial on a short line, the system may be said to be quite successful and practical. The trials were made on a line about a kilometre long, of standard gauge (4ft. $8\frac{1}{2}$in.) Illustrations of the line, of the locomotive, of the 1-phase overhead conductor, and of the novel current-collecting devices were given in the previous article.

The locomotive is much simpler than might be imagined from a description. In fact, it strikes one as hardly more complicated than an ordinary direct current locomotive, and as less complicated than the 3-phase locomotive used on the Lecco-Sondrio (Valtellina line) or those used on the Jungfrau railway. Seeing that the locomotive is actually a combination of a direct-current locomotive, and a motor-generator sub-station on wheels, this impression of simplicity is surprising. It is to be accounted for by the very simple, open, and straightforward mechanical arrangements adopted and by the absence of the resistances, controllers and their connections to which we are accustomed. In an ordinary locomotive these latter things take up a good deal of space, and are always more or less unsightly and unmechanical. It is a very good thing to get rid of them, and still better to avoid the losses and expenses of various sorts that their use involves.

The locomotive used in the trials weighs $41\frac{1}{4}$ tons. Its power is stated as 400 h.p., its normal tractive effort as 3,000 kilogrammes, and its maximum tractive effort as 6,000 kilogrammes. Its full speed is 36 to 40 kilometres an hour—$22\frac{1}{2}$ to 25 miles—not a very high speed, but sufficient for the conditions of the local railway of about 20 kilometres on which it

---

* *The Electrical Magazine*, No. 3, Vol. 1., pp. 265-269.

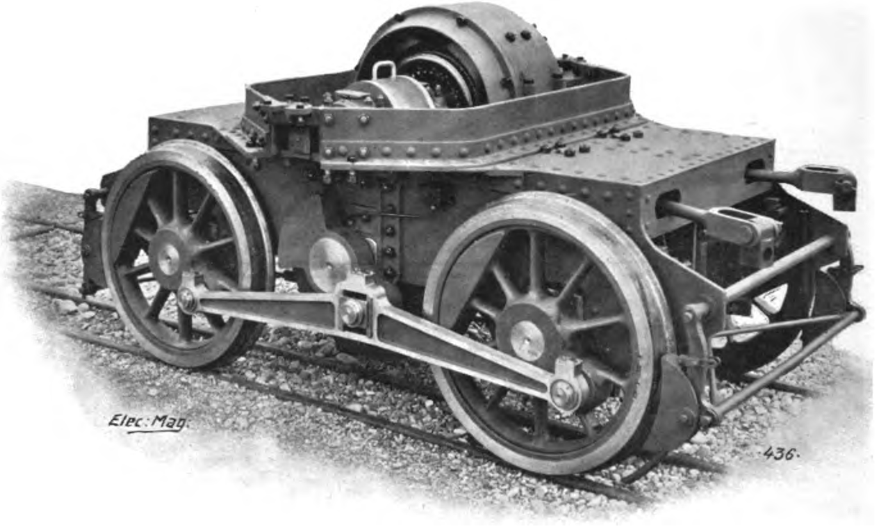


FIG. 1. OERLIKON CO.'S ONE-PHASE ELECTRIC RAILWAY.
(220 h.p. motor with coupled driving wheels).

is intended to use it. So far as the stated power is concerned it will be found that a draw-bar pull of 3,000 kilogrammes at a speed of 40 kilometres an hour corresponds to 440 h.p.

The 4-axle locomotive is driven by two direct-current motors each of 220 h.p. running at a maximum speed of about 600 revolutions per minute, each motor being geared by single reduction bevel-gear to a shaft immediately under the motor, this shaft having outside cranks, the driving wheels being coupled to the driving wheel as in ordinary steam practice. This arrangement is shown in Fig. 1; it has been used by the Oerlikon Co. in other electric traction work—it is simple and efficient. It gives a very un-electrical appearance, the rise and fall of the coupling rods as the locomotive approaches, strongly suggesting a steam locomotive.

The direct-current motors do not differ in any essential from ordinary traction motors. One of them is shown in Fig. 2, with the upper half of the frame removed, showing the armature, commutator, and bevel pinion.

The 400 h.p. motor-generator is shown by Fig. 3. It is mounted in the middle of the locomotive* with its shaft pointing fore and aft. It runs at 1,000 revolutions per minute and consists of a simple squirrel-cage non-synchronous 1-phase motor, directly coupled to an ordinary direct-current generator, the latter being capable of giving 600 ampères at 600 to 700 volts—a maximum of 420 kw.—ample for the power required to be developed by the locomotive.

It will be gathered from Fig. 3 that the two machines forming the motor-generator are mounted on one shaft without any intermediate bearing. Fig. 4 shows the stator of the 1-phase induction motor. It is wound to receive current at either 700 or 15,000 volts, 50 periods per second. During the demonstration it was supplied direct from the overhead line at the latter pressure, and various experiments were made to show that there was no difficulty about this. The very small current at this pressure makes the actual collection very easy. The collector was pulled away from the overhead line repeatedly, and the locomotive was run from a live to a dead section without any serious arcing taking place. The overhead line is fitted up in such a way as to demonstrate the various actions of the collector explained and illustrated in the previous article, such as running under, over, on the side of the conductor, and passing from one conductor to another.

---

* See Fig. 2 of previous article, page 267.

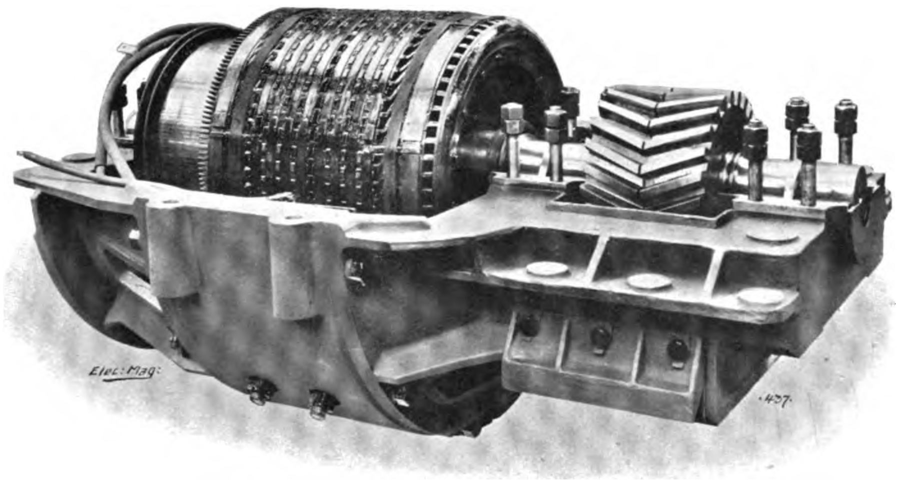


FIG. 2. OERLIKON CO.'S 220 H.P. TRAIN MOTOR.
(Armature and gears exposed.)

A model of a tunnel is built over one part of the railway to show the arrangements of the conductor. It is only necessary to say that under all the conditions shown this very ingenious and simple collecting device acted very well—an important future may confidently be predicted for it.

We may now consider some of the working arrangements of the locomotive.

The direct-current generator is excited by a small exciter, driven by a small 1-phase induction motor—another motor-generator, in fact. It is fed by a 15,000 to 700 volt transformer. This enables a better and quicker control to be obtained

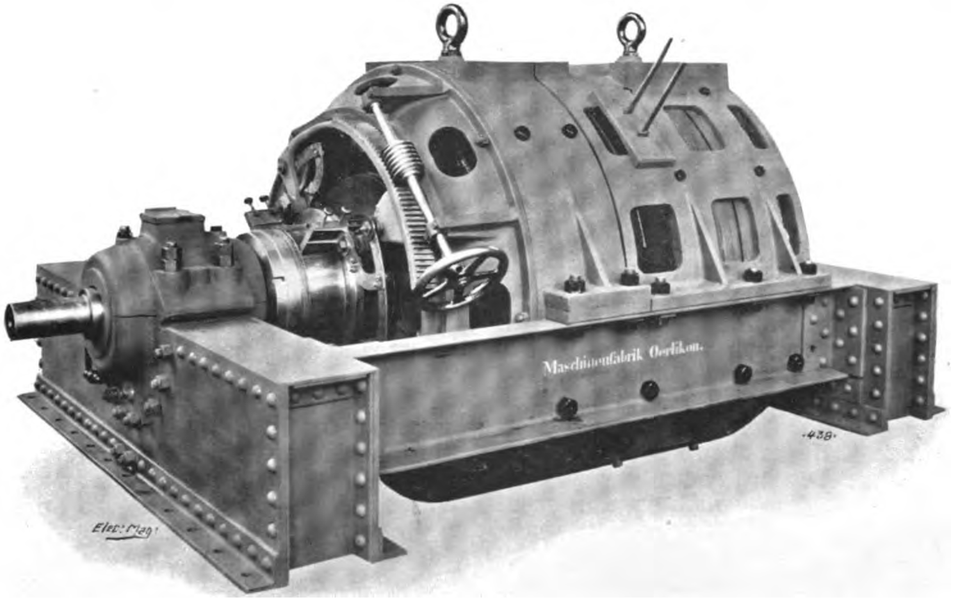


FIG. 3. 400 H.P. MOTOR GENERATOR FOR LOCOMOTIVE.
(Oerlikon Co.)

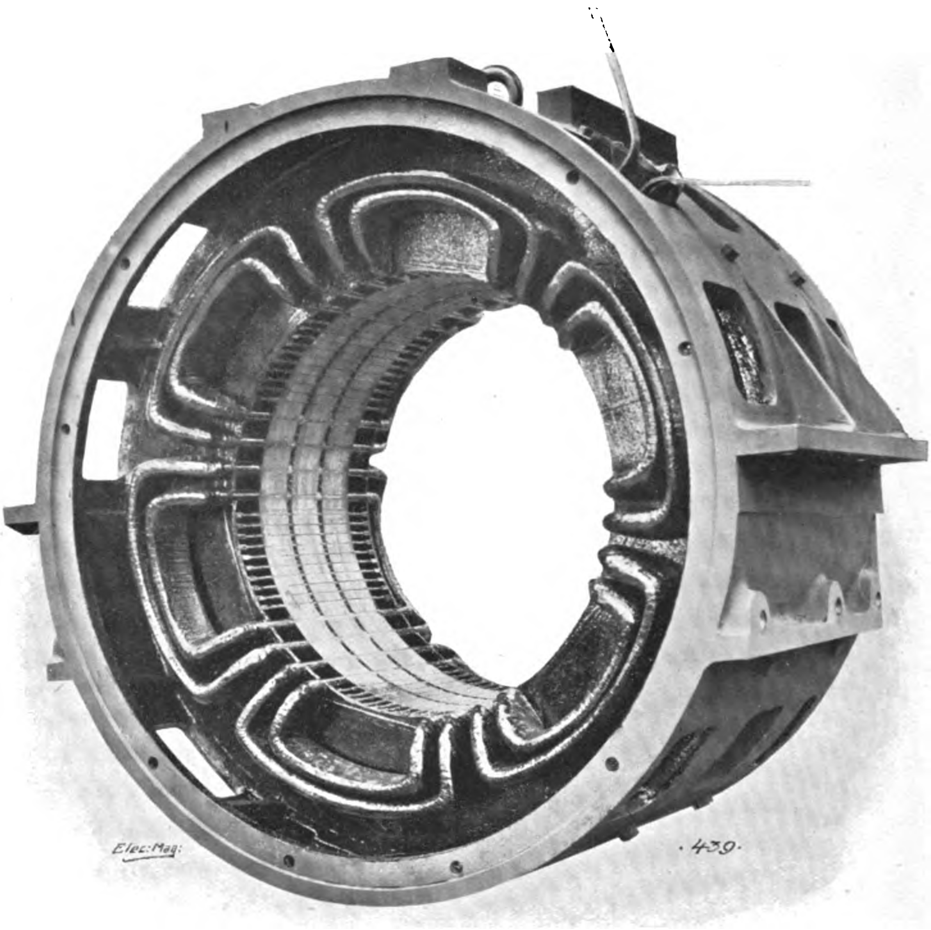


Fig. 4. 400 H P. Motor Generator
(Field or stator of one-phase motor).

of the generator field than would be possible if the generator were self-exciting. Indeed it could hardly be made self-exciting as it has often to work at very low voltages; and, further, it requires to have its field reversed for braking purposes. The excitation might have been provided by an exciter, driven from the large motor-generator shaft (as shown in the diagram of the Ward-Leonard system, at page 266), but although this would save a small induction motor, it would be a less convenient arrangement. One advantage resulting from the use of the separately driven exciter is that, instead of starting the large motor-generator by alternate current from the mains, it is started on the direct-current side by using the exciter to drive the generator up to nearly full speed, when the 1-phase motor is switched on to the line. This operation of starting took five minutes during the trials. It is a very economical arrangement, as it avoids drawing a large current from the mains at a low power-factor. This separate exciter is also used to excite the train motors.

There is still another induction motor on the locomotive—*viz.*, a small one driving an air pump for the air brakes. (This is visible in Fig. 2, page 267). Braking, however, is done electrically by varying the excitation of the generator, and causing the train motors to drive back on to it. This operation is a very simple one in practice, and was shown to be very effective—by one motion of the control wheel, the excitation of the generator was reversed, by which means it received current, and the locomotive was brought to a stop without shock, and the direction of running reversed. The line was not long enough to get any accurate measurement of this method of braking by returning energy to the line, but the fact was demonstrated clearly enough, and the action was shown to be very prompt and powerful, and to be effective even at a very low speed.

The inherent "variable-ratio" properties of the system were also clearly shown, by attempting to start against a very heavy load. A truck loaded with earth, and having its wheels blocked, was hitched to the locomotive, and an attempt was made to start. Although the ammeter in the circuit of the train motors showed more than 700 ampères, the alternate current taken from the mains was only about 13 ampères. It was not possible to take any accurate observations, but this experiment showed roughly, but conclusively, that the claim for this method is well-founded—that it enables a very large starting effort to be exerted with a comparatively small demand on the generating station. The train motors were receiving more than their full current, and were exerting more than their full load torque, although the mains were only being called on for about 38 per cent. of the full load current—and certainly for a good deal less than 38 per cent. of the full load energy. No resistances were used except a very small one in connection with the exciter.

The demonstration at Oerlikon has certainly shown that in this motor-generator system of Ward-Leonard, we have a practical and convenient method of 1-phase alternate current railway traction. Although it is obviously less simple than the direct use of large torque motors, it has features of interest and practical importance, which may very likely lead to its being preferred to those simpler methods for some kinds of work, especially for short lines with many stops. It must not be lost sight of, as previously pointed out, that even on one railway there may be room for different kinds of driving arrangements to suit different kinds of service.

In one respect, the Oerlikon system has an advantage over any of the other arrangements of 1-phase train motors so far proposed—it can work at ordinary periodicities. Other 1-phase motors at present being put forward for railway work are designed for very low frequencies, and require a special generating system, or the use of methods of transformation which would be seriously objectionable—and these low frequencies would be unsuitable for lighting. By adhering to 50 periods per second the Oerlikon Co. is able to do lighting and traction on the same system, and to use any ordinary 50 period alternate current supply that may be available. This is a question which may become very important when considering the possibilities of getting a supply of energy for trains from power stations provided for different districts through which a railway may run. A great deal of harm has been done by the adoption—for various purposes—of frequencies too low for lighting, necessitating the use of rotating transforming machinery, when static transformers should have sufficed. The introduction of alternate current traction will certainly be helped forward very much, if it is found possible to use frequencies suitable for the purposes of general supply, and in this respect the demonstration of the Oerlikon Co., compares favourably with the proposals of other workers in this field.

(To be continued.)

W. M. Mordey.

Single-Phase Railway Motors.

By G. W. *de* TUNZELMANN,
B.Sc., M.I.E.E.

IT has been known for a good many years that, if only the excessive sparking at the commutator could be overcome, alternate current motors could be built with characteristics very closely resembling those of the direct current series motors usually employed in standard electric railway practice. Probably, almost every engineer who has interested himself in the development of alternate current motors, has attempted, more or less seriously, to overcome this difficulty. On paper, the problem seemed such a simple one to solve, especially in the earlier stages of knowledge of alternating current phenomena. When, however, the machine which appeared so promising was actually constructed, it was found, again and again, that the destructive sparking at the commutator made it useless in practice, and the experimenter was driven back to the consideration of the induction motor.

The result has been that the induction motor has been developed to a high degree of efficiency. For traction, hoists, and other purposes where a high initial torque and considerable speed variation are required, the induction motor has inherent defects which have only been remedied by the use of auxiliary apparatus of more or less complication. The recent development of successful alternate current commutator motors has been very largely due to knowledge gained by workers in quite a different direction, *viz.*, the improvement of continuous current dynamos and motors.

These machines have long since been brought to a very high degree of efficiency. Fortunately, however, a large number of workers, mainly in France and Germany, have devoted their time and attention to still further raising the efficiency, and at the same time increasing the durability, of the direct current dynamo and motor, by investigating the conditions under which sparking at the commutator can be reduced to a minimum. The combination of advanced theoretical knowledge, and familiarity with the practice of dynamo design, has characterised the most successful workers in this field, and the result of their work has been a most important advance in our knowledge of the very complicated problem of commutation. The development, in this manner, of the theory of commutation, is now being successfully applied to the removal of the difficulty which had for so long prevented the construction of commutator motors for alternate current circuits. The solution of the problem has also been greatly facilitated by the increasing use of low frequencies, and the several types of motor of this class, which have recently been constructed have all been built for operation on circuits of low frequency.

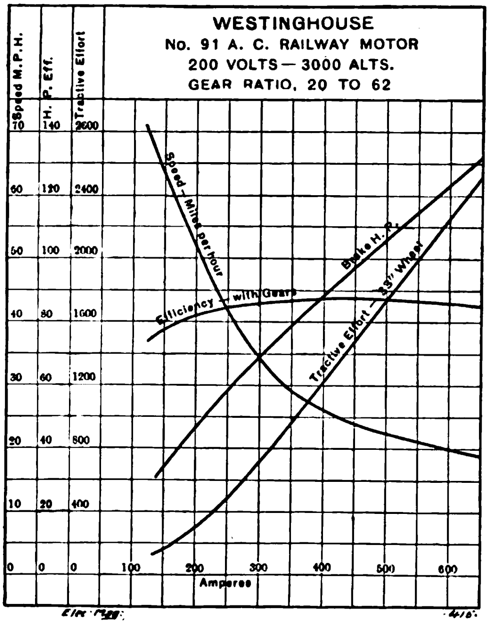


FIG. 1.

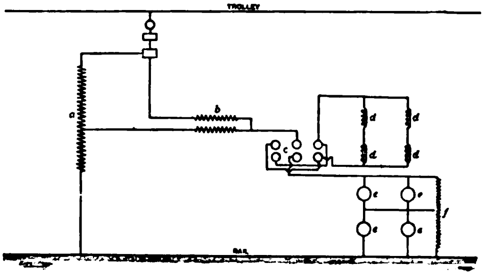


FIG. 2.

An interesting motor of this type is now being made for single-phase railway work by the Westinghouse Manufacturing Company. The close similarity of its characteristics to those of the standard continuous current series motor is very clearly shown by the performance curves illustrated in Fig. 1. The laminated armature core is built up of circular stampings of soft steel, while the laminated field core contains inwardly projecting poles of rectangular section. The field coils of copper strap are connected permanently in series, and the drum type armature core, with open slots, is wound with machine-formed coils of copper strap connected in parallel. There are no band wires over the core, the coils being held in place by

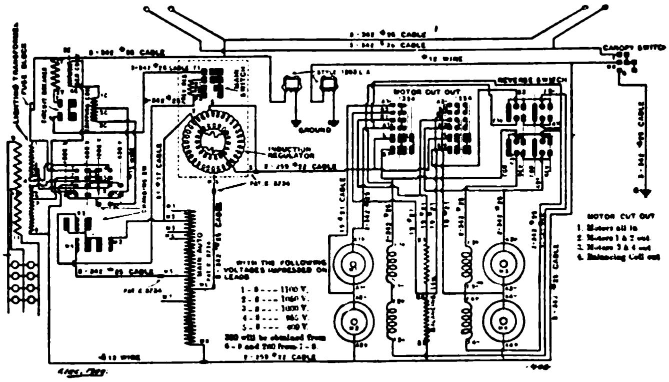


FIG. 3.

retaining wedges of hard fibre, which fit n grooves punched in the armature teeth.

The commutator is built up of cold rolled copper segments. Carbon brushes, with sliding-shunt type brush holders are employed. This particular motor, which is designated No. 91, is wound for 225 volts with a frequency not exceeding 25, and at full speed the revolutions are about 700 per minute.

The speed is controlled by an induction regulator without the use of resistance in series, so that a high operating efficiency is obtained at all speeds. The regulator consists of two coils, shown diagrammatically in Fig. 2, wound on separate cores, and so mounted that their mutual induction can be varied by variations of their relative angular position. By the use of an auto-transformer for reducing the voltage on the trolley line, a voltage range double that of the regulator is obtained, as the E.M.F. in the secondary can be either added to, or subtracted from, that of the auto-transformer.

The regulator and breaker are operated by a worm gear, while the main and reversing switch, and the car circuit-breaker are pneumatically operated, and all are controlled by magnetic valves, operated by a small storage battery.

For the multiple control of a train, all that is required is to carry this low-voltage battery circuit from car to car. Seven-point plugs and sockets provide an easy method for making these connections. Fig. 3 shows the connections of a four-motor equipment. It will be seen that the four motors are arranged in pairs, each consisting of two armatures in series and two fields in series, the two pairs being connected in parallel. This equipment is designed to operate with a trolley voltage of from 1,000 to 1,200.

A.C. POTENTIAL FALL IN RAILWAY RAILS.

EXPERIMENTS made a year ago in the laboratory of the Oerlikon workshops gave the following results: In alternating current railway plants in the neighbourhood of which there are telegraph and telephone connections with earth conductors, the risk of a disturbance cannot be avoided radically but by diminishing to a great extent the loss of tension in the rails. The system designed by the above company (Dr. H. Behn - Eschenburg, *Elektrotechnische Zeitschr.*, April 24th), proposes to avoid the tension loss in the earthed rail conductors by diminishing in these conductors the current intensity itself, and leading this to auxiliary conductors, so that the rails will carry, in any one section, only that current taken by a passing car. In any other sections the return current does not traverse the rails, but the auxiliary conductor. In parallel to the rail circuit S (Fig. 1) where the loss of tension has to be compensated, an auxiliary circuit L is connected to the rails at different points. At these points, the rails and auxiliary circuits are divided into a number of sections S_1, S_2, etc., l_1, l_2, etc. In some sections of these auxiliary circuits, the secondary coils W_2 of ordinary transformers are inserted, the primary windings of which W_1 are connected in series with the trolley wire O. The theory of this arrangement is developed, the connections between the dimensions of the coils W_1, W_2 on the one hand and the ratios of the conductors on the other being ascertained.

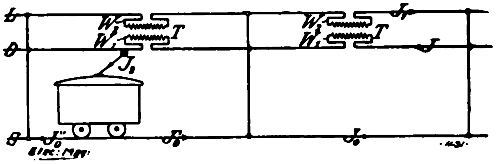


FIG. 1. A.C. CURRENT POTENTIAL FALL.

TRACTION NOTES.

Sliding Bow versus Trolley.

AN article by G. Hooghwinkel, with the above title, in *The Light Railway and Tramway Journal*, of April 1st, calls attention to the successful employment of the bow system on the Sheerness tramways. He points out that 80 per cent. of the electric tramway accidents recorded in the Board of Trade returns are attributable to the trolley wheel jumping the line, a contingency impossible with the bow.

He summarises the advantages of the bow system as follows:

Safety at any speed. Easier handling. Lighter, cheaper and less unsightly overhead gear. Smaller wear of the trolley wire.

Electric Traction in the London Northern Suburbs.

THE *Light Railway and Tramway Journal*, of April 1st, contains an interesting and comprehensive article dealing with the systems of the Metropolitan Electric Tramways, Ltd., partly in operation, and partly in course of construction, in the North London suburbs. A map is given showing the feeders, and the article contains a number of illustrations and drawings of engineering details, together with plans of the Brimsdown power station.

Western Ohio Railway.

The southern division of this line, a distance of 78·6 miles of single track, was completed in December last. The track is of 60 lb. and 70 lb. **T** rail, laid on oak sleepers two feet apart, with 8 in. of broken stone ballasting crowned at the centre. All level crossings are provided with derailers, consisting of 15 ft. switch points normally held open by spring boxes. The switch stands, through which the derailers are operated, are placed on the further side of the track to be crossed, the connection between switch-point and stand being made by suitable lengths of 1 in. gas pipe connected through a bell crank. The trolley wire is hung from Christy flexible brackets. Alternate current is generated at 400 volts, and supplied to the aluminium transmission line, through step-up transformers, at 33,000 volts. There are six substations, including one at the power house, at which rotary convertors convert to continuous current at standard pressure.

Friburg-Morat-Anet Railway.

The 16 mile section, from Friburg to Morat, of this line was originally operated by steam, but has now been converted to electric traction, the 9 mile section from Morat to Anet being added at the time of conversion. Three-phase current at 8,000 volts is supplied from the Friburg Canton hydraulic station, and is converted at substations to 800 volts continuous, and fed to a third-rail. At turnouts the third-rail is replaced by an overhead trolley, to avoid the complication of third-rail switches. At level crossings the third-rail is omitted for a distance of 39 ft., the ends being connected through underground piping. Current is collected from the third-rail by four shoes, connected to the axles, and making contact by gravity, in such a manner that the distance between the shoe supports and the rails is unaffected by the play of the springs. The distance between the front and back contacts is 47 ft.

Rail Bonding.

We welcome the appearance of a paper, by W. E. Harrington, the general manager of the Camden and Suburban Railway Co., in which the subject is treated in considerable detail. The paper was read before the Franklin Institute last October, and is published in the January, February, March, and April numbers of the journal of the Institute. The author sets forth the various types of bonds now in use, and gives detailed illustrated descriptions of some of those most generally employed in the United States; also rail-bonding tools and their use; and methods of testing. Great stress is laid on the importance of frequent inspection and testing, especially over crossings and around special track work. In an interesting communication from Mr. H. P. Brown, which is printed as an appendix to the paper, attention is called to the liability to failure, through oxidisation between the rail and the bond, of the numerous forms of bond, in which due allowance has not been made for the considerable difference in the coefficients of expansion of copper and steel. The writer is strongly in favour of plastic bonds, and he states that bonds of this kind installed in 1895, showed in 1900 an average drop of 0·001 volts, while on the same length of unbroken rail it was 0·003 volts.

Wheels for Tramcars.

Our contemporary, *The Street Railway Review*, in its issue of April 15th, contains some interesting communications from various tramway engineers regarding the relative advantages and disadvantages of chilled-iron and steel-tyred wheels respectively. The most interesting of these is the following tabular statement, contributed by Mr. G. Lironi, the resident engineer to the Portsmouth Corporation Tramways.

Table of comparative cost of Chilled *v.* Steel-Tyred Wheels.

(70,000 miles run).

Life of chilled wheels, 23,000 miles.	£	s.	d.	*Life of steel tyred wheels, 70,000 miles.*	£	s.	d.
4 chilled wheels @ 28/6	5	14	0	4 steel tyres at 28/3	5	13	0
Pressing on axles, 1/6 each	0	6	0	4 wheels re-tyred @ 5/- .. .	1	0	0
Lifting car and putting wheels and gears under car	1	10	0	Lifting car and putting wheels and gears under car	1	10	0
After 23,000 miles—Lift car	1	10	0	5 per cent. depreciation on 4 wheel centres, value 40/- each	0	8	
Push off 4 old wheels and push on 4 new wheels	0	12	0				
4 new wheels ..	5	14	0				
After 46,000 miles—Lift car ...	1	10	0				
Push off 4 old wheels and push on 4 new wheels	0	12	0				
4 new wheels ... =69,000 miles	5	14	0				
	23	2	0		8	11	0
Less credit for 12 old wheels = 1½ tons @ 42/- per ton	3	3	0	Less credit for 4 old tyres @ 2s.	0	8	0
	£19	19	0		£8	3	0

"From the foregoing figures a saving of £11 16s. is effected on a 70,000 car miles run in favour of the use of steel-tyred wheels. As these figures are obtained in practice, I do not think that any further remarks are required as to why steel-tyred wheels should be used in preference to chilled."

There appears to be a very general agreement that the chief trouble with iron wheels is the formation of flats and the cracking and chipping away of the wheel flanges. At Liverpool and Newcastle chilled-iron wheels are stated to give every satisfaction, in spite of the rough usage to which the rolling stock is subjected on both systems. There is no doubt that the quality of both the steel and iron wheels on the market is an extremely variable quality. Very great differences are found to exist in the wearing qualities of wheels of different makers, and in many instances marked differences in quality have been noted even in two consecutive deliveries from the same makers.

LIGHTING and Heating

Under this heading the development of lighting and heating by electricity will receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., will be comprehensively and impartially described and illustrated.

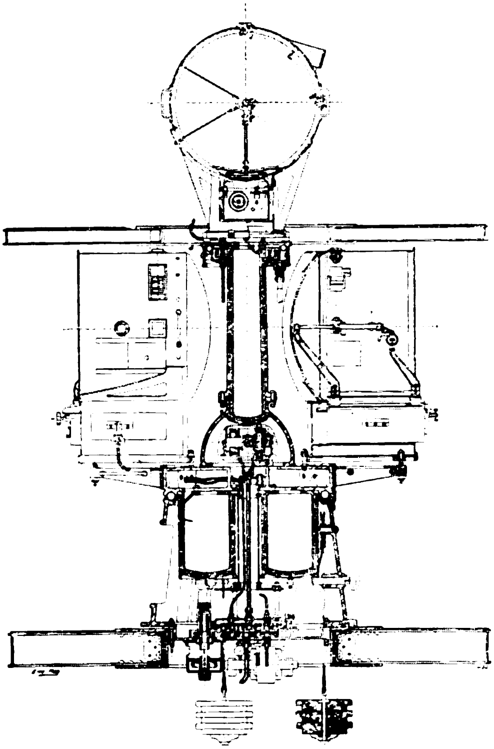
The Electric Lighthouse at Heligoland.

By the ASSOCIATE EDITOR.

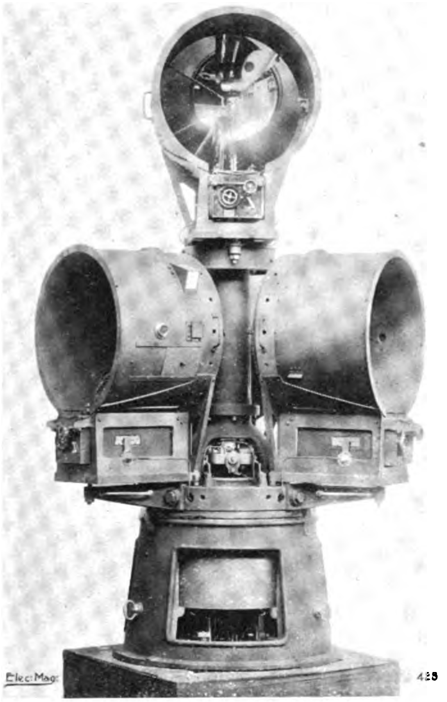
THE oil lamp in the lighthouse is gradually being replaced by the electric light. Opinions have differed as to the penetrating power of the light, in foggy weather for instance; in the streets of London on a November day, the small gas lamps often appear to show to greater advantage than in clearer weather, and this is generally put down to their greater carrying power. Whether this is merely an illusion or not, whether there is any real fact at the bottom of the opposition to electric light as applied to the penetration of a bank of fog, this is not the time or place to discuss. There is, at any rate, one solid fact, which does not admit of dispute, and that is that in the most advanced lighthouses, and those occupying the most important positions on the coast, the electric light is being gradually introduced. A recent number of the *Electrotechnische Zeitschrift* has a full and illustrated description of the new arrangements which have been adopted for the lighthouse at Heligoland, occupying one of the most important points on the German coast at the entrance to the Elbe and the port of Hamburg. The height of the light above high water mark is 270 ft., and it can be seen by an observer, standing 12 ft. above the level of the water, at a distance of about 25 miles in clear weather. The particulars given by Herr O. Krell are of much interest. The installation is one of the largest in the world, the total light emitted being not less than 30 million candle power, and the duration of the flash about one-tenth of a second. The flashes follow one another at intervals of 5 seconds, and in this way the light can be identified by the observer. These results are obtained by erecting three reflectors, placed at angles of 120 degrees, on a rotating platform, the reflectors being 30 inches in diameter, and of paraboloidal form with a focal length of rather less than 10 inches. The lamps are supplied with direct current, each taking 34 ampères;

HELIGOLAND LIGHTHOUSE AT NIGHT.

the platform makes four revolutions a minute, and the crater of the positive carbon has a diameter of 9·7 mm. The principles on which lighthouse illumination has been in general arranged in the past has been that, for effective radiation, a flash of one-tenth of a second is the shortest permissible. Experiments are, however, by no means conclusive, partly on account of the difficulty of reaching definite results with trials of this nature, and partly because, in a matter which may involve serious questions of life and death, experiments can only be undertaken with great caution. The general consensus of opinion has hitherto been in favour of a light of a duration of one-tenth of a second. But in order to satisfy a more scientific and experimental examination of the question, it is hoped to be able to carry out a series of tests at Heligoland, by means of a fourth reflector, which will be erected and have a flash of one-thirtieth of a second. The usual method for rotating the platform is to turn it about a vertical axis, which is so arranged that it maintains the platform in a horizontal position. In the present case, a slightly different arrangement is preferred; the platform is placed on a ring of steel balls; both the ring and the balls themselves are of the largest possible diameter in order to secure thorough stability. The vertical axis is therefore unnecessary for the purpose of ensuring a horizontal position for the platform. A great advantage of this arrangement is that the space previously occupied by the axis is now free for the electrical connections which have to be made between the stationary and rotating parts, and as there are several such connections to be made, this advantage is of great importance. Below the centre of the platform are arranged six mercury contacts for conveying current to the lamps and the motor driving the platform. These mercury contacts consist of iron ring-shaped basins, containing mercury, insulated from one another by mica. Into these mercury basins dip switches, which are mounted on a rotating slab, and connected to terminals leading to the various parts of the machinery. The arc must always be kept in the focus of the reflector. For this purpose, small mirrors and lenses are mounted by which an image of the arc is thrown on pieces of opal glass, which are mounted on the case of the reflector. On these opal glasses are vertical and horizontal marks, and the position of the arc has to be so adjusted that the horizontal line passes through the centre of both carbons and the vertical line through the tip of the positive crater. When this adjustment is made, it is known that the arc is in the focus of the paraboloidal reflector. For purposes of adjustment, the lamp can be moved bodily in the direction of the axis of the reflector, the positive carbon can be moved both vertically and horizontally, and the negative carbon is capable of vertical motion. The carbons are placed horizontally in the optical axis of the reflector, and the lamps employed are of the ordinary shunt type, made by Schuckert. The general appearance of the optical apparatus is shown in our illustrations. The whole of the switching arrangements are made in a room immediately below the lantern. Current is brought from a small station, distant about 220 yds. The machines are two steam dynamos, giving 216 ampères at from 65 to 75 volts. One of these machines is used as a spare in case of need. They give more current than is actually required by the tower, but the surplus current is usefully applied in other directions for lighting the buildings. The makers carried out tests at their works, in order to see that the lamps complied with the specification, which was to the effect that the minimum light emitted was to be 30 million Hefner candles. It was found that with a voltage of 45, a mean candle power of 34 millions was obtained with 26 ampères supplied to each lamp, the maximum of eleven readings being over 39 millions. With 34 ampères, a maximum of nearly 43 millions was obtained at the works at Nuremberg, and on the sea coast, with a clearer atmosphere, better results than this were to be expected. The readings were taken at a distance of 1,450 yards with a Weber photometer. As for the construction of the reflector, by



SECTIONAL VIEW OF LIGHTHOUSE LAMPS AND MECHANISM.



Three Complete Lamps for the Lighthouse.

drawing a curve showing the intensity of emission in various directions from the crater of the arc, and placing the crater in the focus of the parabola, it is found that a reflector having a diameter equal to three times its focal length would collect practically all the light, and convert it into a beam consisting of parallel rays. If the crater of the arc was a mathematical point, the emitted beam would consist of parallel rays; but seeing this is not the case, the rays have a slight divergence. In the case of the Heligoland lighthouse, the angle of the cone so formed is 2° 14′. Originally the reflectors were constructed of metal. In 1850 a new arrangement was adopted for the first time at the lighthouse on the Pedra-Branca Rock, near Singapore, in which a combination was adopted of Fresnel lenses with concentric totally reflecting prism rings. By this method, an increase of 10 per cent. in the light emission was obtained with highly polished metal reflectors. Since that time the art of grinding glass has been much improved, consequently glass reflectors have come into use, coated with silver, which acts as the reflecting surface. This lighthouse may be taken as representing the latest development of the art and science of the specialist in this direction. Having regard to the volume of ocean going traffic which passes beneath its light, it may well be called upon to be up to the latest requirements of an exacting public.

THE BENARD ENCLOSED LAMP.

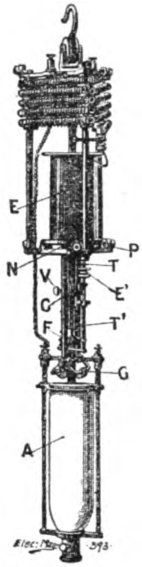


Fig. 1.

Fig. 1 gives a general view of this lamp. P is a plate supporting the whole apparatus, E an electro fixed to P, N a hollow soft iron core in which the positive carbon slides, F a brake which regulates the fall of the carbon, A a crystal bulb, and G a pair of clutches which stop the carbon when it is worn out and ensures automatic extinction. Brake F comprises a steel knife-edge, supported by a lever pivotted at N, the other extremity being fitted to a rod T, carrying a thread and two nuts E¹, which pass through a lateral hole in collar C, held by a binding screw V against a tube T¹, which guides the core. On closing circuit the core is raised and the brake draws the carbon, which causes the core to descend; the brake then gradually releases its hold and allows the carbon to fall. The lamp takes from ·8 to 1 ampère at 220 volts, and 1·5 to 1·7 amp. at 110 volts. It can be mounted in parallel like an incandescent lamp without requiring a resistance, and consumes less than 1 watt per decimal candle power. The curve of luminous intensity shown in Fig. 2 was plotted at the Faraday Institute, the terminal P.D. being 110 volts. The consumption of the carbons was, for the positive ·75 cm, and for the negative carbon ·42 cm. per hour.

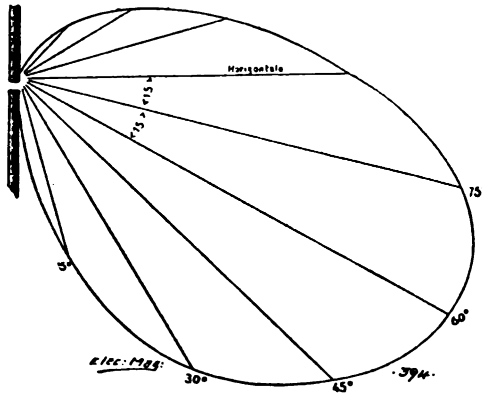


Fig 2.

THE ALTERNATE CURRENT ARC.

Some years ago Mrs. Ayrton published papers referring to the working of the electric arc, more particularly concerning herself with the direct current arc. Both before that time and since, the question has also engaged the attention of other observers, and now M. F. Laporte has added *(Bulletin de la Société Internationale des Electriciens)* to the literature of the subject by an important contribution dealing with the alternate current arc. His results are of practical importance, and deal essentially with the economy which may be expected under different conditions. In this respect too much is often left to chance; the conditions under which the best effects are produced are not always well understood, and considerations, altogether apart from questions of efficiency, often decide the manufacturer to design his lamp to burn under conditions which are not the best suited to give the maximum output for the energy consumed. M. Laporte, therefore, does well to remind us of a few hard facts, and the main points of his paper, briefly considered, may help to throw light on some of the dark places. Taking a cored carbon, 13 mm. in diameter, for the upper electrode, and a solid carbon, 12 mm. in diameter, for the lower, he found that with 25 volts it was possible to produce a very short hissing arc, which caused irregular mushrooms on both carbons. For a given current, the luminous intensity is a maximum with a voltage of about 33; above this pressure it decreases, and this is probably due to the fact that the increased length of the arc causes a larger surface of incandescent vapour to be exposed to the cooling action of the atmosphere, and thus lowers the temperature of the arc. The hissing ceases with a pressure of about 30 volts. The power factor of the arc is very noticeably less than unity for voltages below 30, *i.e.*, for pressures corresponding to the hissing arc, and may even be less than 0·9. It increases with the pressure, and reaches a value between 0·93 and 0·97 when the arc ceases to hiss. After this it remains constant, or nearly so, with a slight tendency to fall at the higher pressures. Taking again the case of constant current, it is found that the ratio of candle power to watts is a maximum for pressures between 30 and 32 volts; at 45 volts the ratio has fallen to half its maximum value. This again seems to point to a pressure of about 32 volts as being the best, having regard to the results of these observations, the pressure being presumably measured across the carbons themselves, and not at the terminals of the lamp. The results, no doubt, are not of general application, as allowance would have to be made, under any given conditions, for the wave form of the alternator, for the size of the carbons used, for the reactance in series with the arc, and for other details. Still, in general outline they seem clearly enough to point to the fact that under the given conditions of the tests, a voltage of about 33 was the best, if the object is to obtain a maximum illumination with the expenditure of the minimum amount of energy. Ordinarily it is usual to find a voltage higher than this to be specified by makers to be used with their lamps; but in view of the facts, it seems doubtful whether any higher voltage is really necessary, unless some margin is desirable in view of imperfections of mechanism.

LIGHTING AND HEATING NOTES.

The Licensed Wireman.

THE incompetent wireman has been a source of anxiety to his employer in the past, and the method of detecting inexperience is rough and ready. Possibly the man is not found out till the damage is done. In the District of Columbia, in America, it is proposed to put an end to this state of things, but it is not evident that mere Acts of Parliament will be sufficient to turn the inexperienced workman into a competent one. Still, the proposal before the legislature is to the effect that it shall be unlawful for any person to act as an electrical wiring contractor, or to engage in electrical construction or installation, unless he has been properly licensed, or is working under the supervision of a licensed person. Moreover, any person employing an uulicensed contractor would be liable to fine, and it is proposed, if the fine is not paid, to confine the offender in the workhouse for a period not exceeding six months. Truly this would add something to the terrors of existence. When the Act has been in operation for a year, it will be interesting to hear how it is found to work; but such legislation as this makes one feel inclined to think with Herbert Spencer that we suffer from too many rather than from too few laws.

A New Arc Lamp.

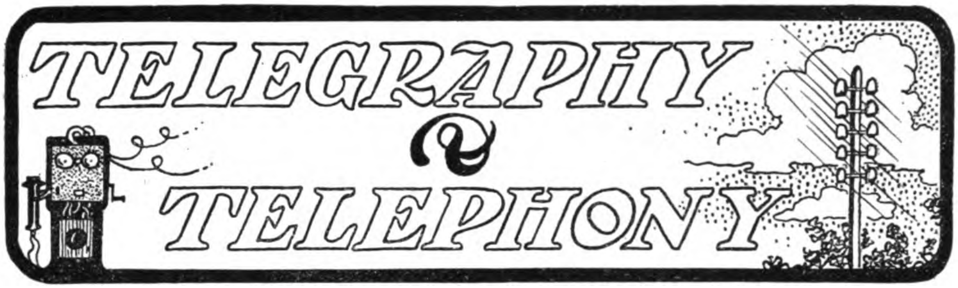
WE have recently inspected a new arc lamp, the invention of Mr. L. C. H. Mensing, which promises to simplify not to say revolutionise, arc lighting. It has but one controlling coil, one moving part and a magazine to hold 21 pairs of carbons, giving a life of anything up to 300 hours. The carbons are above the arc, which can distribute its light without casting shadows of carbon rods, or carbons, as is common in many lamps. The design is the embodiment of simplicity, and we shall present our readers with an illustrated account in our next issue. Meantime we announce with pleasure the appearance of what seems to us an epoch making device in the arc lighting world.

Gas versus Electricity.

IN Manchester, another competition is to take place between the two rivals. Hitherto the Electricity Committee of the Corporation has made various isolated attempts to carry out street lighting on an extended scale, but the Gas Committee has more or less consistently opposed such extensions, and has regarded with jealous eye any attempt to deprive them of their monopoly. It is now intended to have something of the nature of an informal competition between the two lights, and the part round the Royal Infirmary has been selected as the site for the tests. It is therefore proposed that the electric light shall be installed in front of the Infirmary Buildings, and the gas lamps are to be distributed on the other three sides. The Gas Committee lays great stress on economy, while their rivals say that their watchword is efficiency.

The Incandescent Lamp in America.

IN this country, we hear little nowadays of legal contentions in connection with incandescent lamps. We, therefore, read with amusement of the fact that the Edison Electric Light Co. and the General Electric Co. of America have agreed to discontinue thirty infringement suits against manufacturers, dealers, and consumers, in view of the arrangement by which they are to receive royalties on lamps sold. We do not know what the precise points are which were to be raised in dispute; probably they were in connection with improved methods of creating the vacuum in lamps.



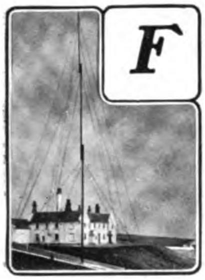
TELEGRAPHY & TELEPHONY

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegraphic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

* * *

Progress of the Telegraph in India.

By E. O. WALKER, C.I.E., M.I.E.E.



Fifty years ago Sir William O'Shaughnessey was instituting, in the neighbourhood of Calcutta, with the aid of heavy iron wires and uninsulated wooden posts, in the face of climatic and other difficulties, the experiments which have led, in the course of half a century, to the establishment of a vast network of wires reaching the extreme limits of the empire. The names of his successors, Robinson, Murray, Cappel, Champain, Mallock, Brovoke, Schwendler and others, associated in the gradual construction and development of this great system, cannot be forgotten in this connection, and were some of them here to-day, we doubt whether they would not acknowledge that the original estimate of their times had been a great deal more than fulfilled. The first line made its appearance in 1851-52, and we believe that it was built from Calcutta to Diamond Harbour, not far from the bank of the Houghly, and passing in its course near the site of the temple of Kali, where bloody sacrifices are still performed notwithstanding the influence of the modern civilisation which reigns in Calcutta. To-day, that single thread, winding its way through tamarind and banyan trees, has grown into a stupendous net of wires extending, if joined end to end, to over 200,000 miles, and carried on nearly 70,000 miles of poles. Those poles have been manufactured mainly out of British galvanized sheet iron or steel, and the weight in tons of metal rolled in our mills to produce this large quantity would afford an interesting calculation. The wire drawers are still busy, adding eight to ten thousand miles yearly to the lines of India, and so doubtless it will continue. At the beginning there were six offices open for public telegrams and to-day there are over 2,000, exclusive of railway offices. By educating the postal clerks to a knowledge of Morse signalling a great impetus was given to telegraph extensions which could thus be carried out at a moderate cost, and in this way the wire was carried to remote towns which would otherwise have had to do without it. In the last 20 years, 1,800 such offices have been opened.

So great a growth has led to large requirements in the staff which consists, at present, of 101 superior officers and 292 upper subordinates, in addition, of course, to operators, clerks, and line establishment.

To aid in rapid disposal of the growing traffic, the Wheatstone Automatic System has been called in, and proved invaluable in times of pressure and of prolonged interruption, as well as for press messages. It was especially acceptable at the Delhi Coronation Durbar, and withont it the very heavy traffic would have overwhelmed the lines. A rate of 100 words per minute is attained, and successful operation is secured between Calcutta and Rangoon, Bombay, Madras, Lahore, and other places, with the aid, we understand, of copper wire circuits. The Indian Department has not been behindhand with wireless telegraphy, communication having been experimentally effected between Sangor Island and the Sandheads, where the pilot brig lies.

In the last year under review, a terrific cyclone destroyed fifty miles of telegraph lines in Sind, and the local officers, under Mr. Sutherland, with strenuous efforts, under a burning sun in the month of May, raised a temporary line in five days, a very creditable performance.

The Delhi Durbar required over 800 miles of wire to itself, and it can be imagined with sixty special correspondents present, that the offices were considerably exercised with news ship. The Durbar speech was telegraphed verbatim to London, the first reputed instance of such an occurrence. The work was done in so creditable a manner all round the camp that the superintendent, Mr. Lees, comes in for deserved praise.

It is to be regretted that, consequent on the reduction of rates with Europe, there is still a loss, although it has been followed by an increase in traffic of 26%. No doubt, in time, this deficiency will be made up, the general experience of reduced tariffs and improved facilities lending colour to this expectation.

All these great achievements in India have not been secured without much exposure, suffering, and the loss of valuable lives. Fire, flood, famine, and the vicissitudes of climate have caused the death of perhaps half the devoted men who have ungrudgingly and unostentatiously gone about their daily duties in the parched plain of the Deccan, the malarious forests of Burmah, Assam, and Kanara, and across the arid tracts of Sind and the Punjab, ever seeking to eliminate weak links and to improve existing methods, often in a state of health which would have been deemed sufficient to incapacitate them from work even in a temperate, much more in a tropical climate. We are glad to think, in these circumstances, that their services have, from time to time, been generously acknowledged by the Government. No one was more quick to recognise the nature of these services, when the military telegraph came rapidly to the front in every frontier campaign in India, than the late Commander-in-Chief, Earl Roberts, who had many times seen the good work done, whether in the jungles of Burmah, or in the snows of Chitral and Afghanistan.

◆

AUTOMATIC TELEPHONES IN THE UNITED STATES.

By our AMERICAN ASSOCIATE EDITOR.

AUTOMATIC telephony has reached a stage in this country that entitles it to serious consideration. Following is a partial list of the cities with automatic exchanges and the figures show equipment installed. These exchanges are "Independent," that is, are not owned by the American Bell Telephone Company.

	Present Installation Lines.
Chicago, Ill.; Illinois Tunnel Co.	10,000
Dayton, Ohio; Home Telephone Co. (See Fig. 3) ...	6,000
Grand Rapids, Mich.; Citizens Telephone Co. ...	5,300
Portland, Me.; Northeastern Telephone Co. ...	2,500
Lincoln, Neb.; Lincoln Telephone Co.	3,000
Auburn, N.Y.; Auburn Telephone Co....	1,200
Fall River, Mass.; Fall River Auto. Telephone Co...	1,200
New Bedford, Mass.; New Bedford Auto. Tel. Co.	800
Augusta, Ga.; Augusta Telephone and Electricity Co.	800
St. Mary's, Ohio; St. Mary's Telephone Co.	500
Columbus, Ga.; Columbus Auto. Telephone Co. ...	700

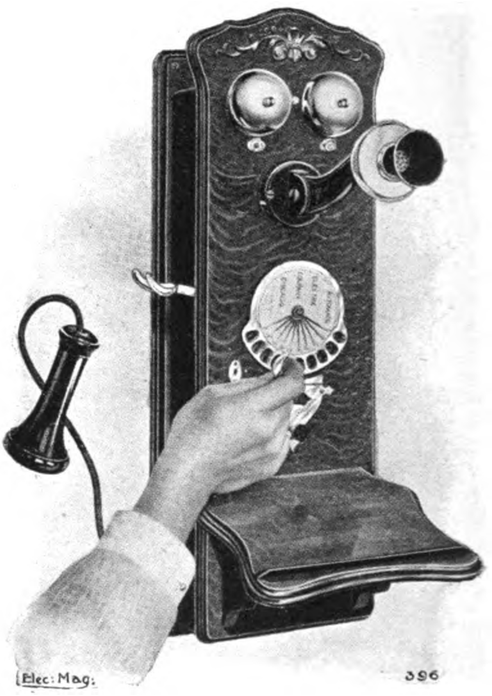


FIG. I. AUTOMATIC TELEPHONE.

This list alone totals more than 31,000 line equipments, and several smaller installations and other larger ones, now under weigh, have been omitted. The majority of telephone engineers have been inclined to condemn the automatic. The automatic manufacturers claim that the condemnation is due to prejudice alone, and that soon this method will replace the manual system of operating. The automatic concerns enumerate as eleven advantages attendant on their system the following:

First—The automatic has no operators, eliminating operator hire.

Second—There being no operators, the automatic exchange can be located in less expensive quarters than the manual. No reading or retiring rooms are needed, no lockers, no lavatories. The cost of fuel and lighting is reduced.

Third—One switchboard attendant only, for testing and keeping apparatus in order for one thousand subscribers, is needed in the automatic practice.

Fourth—Maintenance of switchboard and interior equipment is no greater, and in large exchanges it is less than in the manual exchange.

Fifth—The service which the automatic system gives, unlike that of the manual, is absolutely secret. Each subscriber has a "private wire."

Sixth—In the automatic practice the subscriber himself connects with the person he wishes to call. It is an impossibility for another subscriber to "cut in" upon, or in any way interfere with, the line he is using.

Seventh—The frequent delays and mistakes which the manual board causes are entirely unknown to the users of automatic telephones.

Eighth—The automatic exchange will do away with the so-called "telephone paradox" that the complexity of the exchange abnormally increases with the size, and the cost per subscriber of giving good service to be much greater in large than in small exchanges. With the automatic exchange, the cost of operation is fixed. An increase is a matter of adding new telephones and switches, the cost of operation being the same per subscriber.

Ninth—The automatic switch is cosmopolitan in its nature. No interpreter would be needed by a foreigner for securing a connection.

Tenth—In the manual practice the number of operators is increased during the busy hours and decreased when the night comes on. Oftentimes this decrease of force is greater than the decrease of business will warrant, some special event or catastrophe sending in a number of hurry calls which the depleted force cannot handle. This can never happen with the automatic exchange which always has as many operators or switches as callers.

Eleventh—In addition to the above the following advantages afforded by the automatic exchange may be noted: (1) Quick connections; (2) Instantaneous disconnections; (3). Prompt answers secured from the called subscriber; (4) The accuracy and promptness with which the busy signal is always given where the subscriber is actually busy.

The advocates of the manual claim that there will be no great saving in maintenance or operation where the automatic is used, that the equipment is apt to get out of order, and that instead of following the usual trend and trying to make subscriber's sub-station and the subscriber's end of the line, as simple as possible, the automatic complicates them. The automatic system that has the largest sale uses local battery for talking which requires inspection—this does seem like a step backward after the prefection of the central battery system.

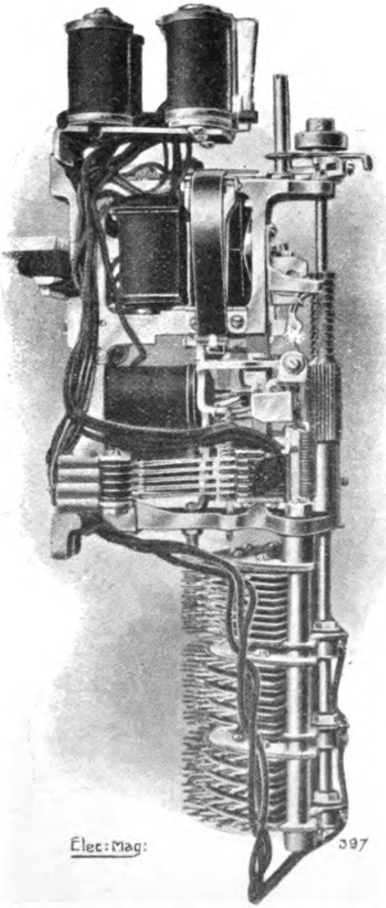


FIG. 2. AUTOMATIC TELEPHONE SWITCH.

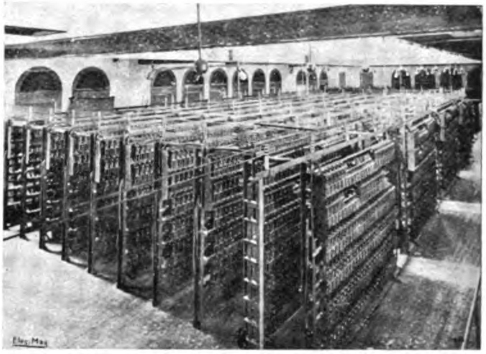


FIG. 3. INTERIOR AUTOMATIC TELEPHONE EXCHANGE.

The principal question, however, in the mind of the broad telephonist, is whether the subscriber, who is used to central energy working and being waited upon by the central office operator, will take favourably to doing his own operating. Which would the busy man rather do: give the number he desires to a brisk speaking operator, or get it himself by working a dial back and forth with his first finger?

None of the automatic exchanges in the large cities where they have to compete with Bell central energy plants have been in operation long enough so that any of the proposed questions can be intelligently answered. No one seems to know now, but another year and some annual reports will tell the story.

Fig. 1 shows the ordinary wall type telephone. There are ten holes in the circular disc. Each one of them corresponds to a digit, and if it were wished to call number 349, the finger would be placed in the 3 hole and the dial revolved until the finger strikes the stop, just as it has in Fig. 1 (normally the dial is in such a position that the words on it are horizontal). The same act is repeated, using the 4 hole and the 9 hole. Then the ringing key, the black button below the dial, is pressed. This rings 349, and as soon as the called party (349) responds the conversation may be commenced.

The revolving of the dial by the finger works a selector at the central office. Fig. 2 shows a side view of a ***selector*** or automatic switch. In an exchange of under 100 lines there is one automatic switch for each line, and in exchanges of from 100 to 1,000 lines there is an automatic switch for each line, and in addition there are 10 automatic switches, called connector switches, for each group of 100 lines, which perform the function of "trunking" or transferring a call, where the called for line teminates in a different section from that in which the call originates. As a rule, the switches are arranged in sections of 100 each.

In the automatic switch (Fig. 2) the vertical rod, which performs the switching function, has a vertical and rotary motion, each controlled by one of the magnets shown, which, in turn, are actuated by the movement of the finger dial at the subscriber's station. For instance: In calling number

34, the first movement of the finger dial would raise the selector rod and the contact arm to the third row of contacts shown, each pair corresponding to a subscriber's line. The second movement of the dial would revolve the contact arm and rod to the fourth set of contacts in the third row. Then the subscriber, by pressing the ringing key at his instrument, would signal number 34 by means of supplied ringing current. Replacing the receivers restores conditions to normal.

Roughly, the apparatus at the subscriber's instrument consists of a make and break or, as it is technically known, a "step by step" mechanism, which allows a certain number of current impulses, determined by the turning of the finger dial, to actuate the magnets on the automatic switch. Automatically operated *busy tests* and *out-of-order* signals are provided. Where a station with a number 1,000 or above is called, the call is automatically trunked, by means of the connector switches, to another section in which the called line terminates.

◆

A TELEPHONE EXCHANGE STORAGE BATTERY EXPLORER.

A SIMPLE "home-made" device has recently been proposed which is of considerable assistance to the telephone "wire chief" when locating or removing particles lodged between plates of accumulators under his care. The arrangement consists essentially of a handle on the end of which is a switchboard signal lamp encased in a small glass vial. From the vial there is a small rubber covered lead pipe extending a reasonable distance. The outer ends of these lamps terminate in testing (suspender) clips. These conductors extend through the tube. To use the apparatus, the suspender clips are connected across as many cells of the storage battery as will give the proper voltage for the lamp. (The lamp should be a low voltage one, so that it will not be necessary to reach across many cells with the clips.) The lamp lighted, the operator can probe between the plates, lighting his way, and can push to the bottom of or lift from the tank anything causing trouble. A periodical minute storage battery inspection is practicable where the "wire chief" is provided with an explorer of this type.

Referring to the figures: Fig. 1 shows an assembly sketch of the whole apparatus. D^1 and D^2 are the suspender clips to attach to the battery terminals which serve as a source of voltage. *A* is a wooden handle, *B* is the small lead pipe which extends down through the rubber tube *C* and into the neck of the small glass vial *E*. The tube *B* must be of lead for if any other metal is used the electrolyte will act upon it. The length *C* should actually be much longer than the drawing shows as it should be sufficient to reach to the bottom of the battery tank. A rubber band *F* is placed around the rubber hose *C* to hold it tightly to the neck of the bottle.

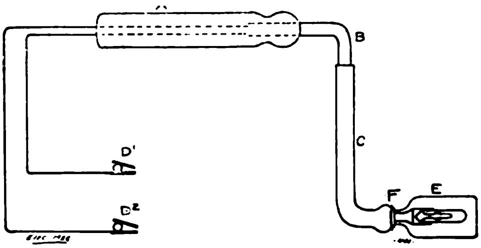


FIG. 1

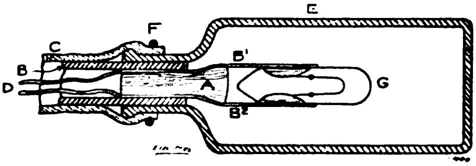


FIG. 2.

Fig. 2 is a cross section of the vial *E*. At *B* is the small lead pipe, at *D* the conductors which are soldered to the terminals of the switchboard lamp *G*. *F* is the rubber band which holds the small rubber hose closely to the neck of the vial *E*. *A* is a wooden plug which is slotted to provide for the conductors B^1 and B^2 which supply the lamp with current. The plug is made to fit snugly into the lead pipe and support the lamp rigidly. The middle tube *C* must be long enough to protect well above the surface of the electrolyte when the lamp *C* is at the bottom of the tank, otherwise there is the probability of a dangerous short-circuit. Dimensions are not given, as special ones would be required for each type of accumulator. In a general way, the vial *E* may be ⅝in. outside dia. and 2½ inches long. The small lead pipe should be of such size as to fit closely into the neck of the bottle.

◆

ELECTRICALLY CONTROLLED CLOCKS.

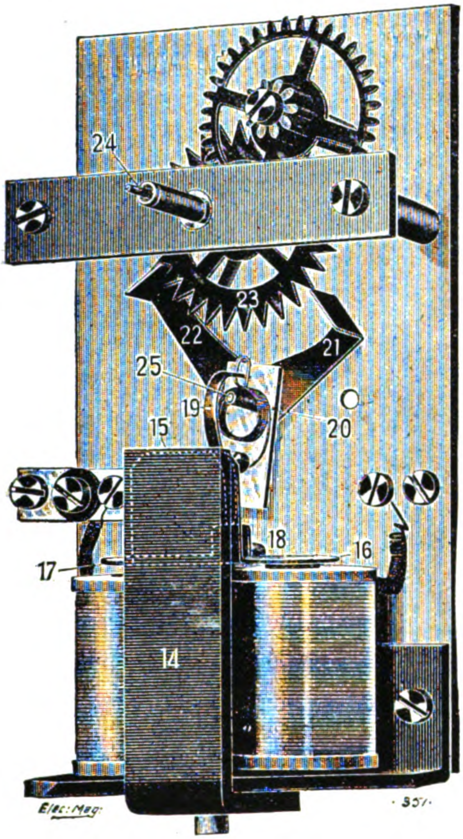
THE operation and control of clocks by the electric current having its source at a master clock are gaining ground year by year. The employment of primary and secondary cells for furnishing the current is not always convenient, owing to inconstancy and fall in voltage. M. Martin Fischer, of Zurich, in his horological system "Magneta," uses a magnetic inductor as generator. An armature of soft iron wound with a bobbin of wire is displaced in the field of two magnets by an abrupt movement once a minute. The principal clock, and the train of wheels which acts upon the armature are actuated by weights or spring. All the clocks to be regulated or controlled are in circuit with the bobbin of the armature, which gives out currents of both signs at each movement. It has been found that less than 3 milliampères suffice to work 8 clocks, and taking the time of contact into calculation the expenditure of current for a year would be only 0·4 ampère hour. The mechanism of one of the controlled clocks is exhibited in the illustration.

The wheel 23, on the axis 24 of which is fixed the minute hand is actuated by the escapement 21, 22, pivotted on a pin 25. The escapement is connected with the armature rocking on the axis 18, when a current is received in the polarised electro-magnet 16, 18. The consequent movement

Erratum.

Page 504.

In the article, "A Telephone Exchange Storage Battery Explorer," the word "Explorer" should read "Exploder."



Electric Clock Mechanism.

of the hands will be understood from the illustration. M. E. Hospitalier states, in reference to this system, that clocks installed on this system have been working without any stoppage for nearly 3 months, during which time 125,000 current impulses have been transmitted.

IMPROVEMENTS IN THE BAUDOT TELEGRAPH.

In a communication to the *Revue Internationale de l'Electricite*, M. A. de Grandmaison, while admitting the important results obtained by M. G. Dubreuil in introducing three keys additional to the five hitherto used by each sender, points out that, in a patent of November, 1900, he has in a measure himself indicated the direction in which such improvement could be effected, by adopting a sixth contact following the five used ordinarily in the Baudot for the transmission of a letter, this addition serving for a space to separate words. The characteristic feature of the system is the same as Dubreuil's, namely, to augment the number of emissions sent at each revolution of the distributor by each operator, while preserving the combinations of the Baudot. The rapidity of transmission would thus be increased by signalling the space, which follows each word, at the same time, or, nearly at the same time, as the last letter of that word. A supplementary current sent by a sixth sector is caused to move the paper band the requisite distance. The mode of operation is explained by the figure. The sectors of one of the four operators' positions is here shown on the distributor for quadruplex working.

The axis A carries an arm on which are mounted four brushes: the brush b^4 rubs on a sector in communication with a local battery; it is connected to the brush b^1 which makes contact with sectors S^1 and S^2. When the brush b^1 reaches the former, the local current, thus brought into play, operates the hammer which causes a letter to be impressed, and upon touching the latter, a current flows through electro magnets E, E^1 and line S^2, which are joined in derivation. It will be observed that electro E^1 is only in circuit when E^6, connected to a sector of the distributor, has received current from the line and has attracted its armature. When E^1 is operated, clockwork causes F, F^1 to turn. When an inverse current is received in E^6 the armature is released and movements are no longer effected. The advance of the paper is produced by a differential movement of F and F^1, which has the effect of doubling the rate of unrolling of the paper which would be due to the individual motion of each. We shall return to a consideration of this system as applied to translation as well as to the improvements effected by Dubreuil in a future issue.

Telegraph and Telephone men will be furthering their interests by procuring "The Electrical Magazine" for this particular section alone. They will thus possess a monthly record of work in their particular spheres, in addition to a compendium of information on other electrical matters.

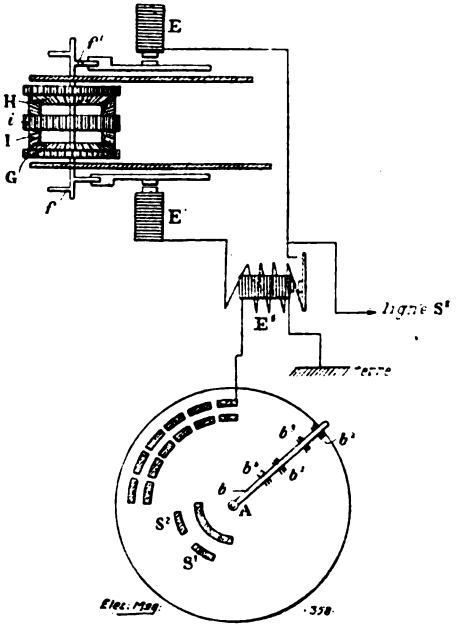


Fig. 1. Baudot Telegraph Diagram

INCREASING THE TRANSMITTER ENERGY.

THE closed circuit system of wireless telegraphy, so closely connected with the name of Prof. Ferdinand Braun, is so well known and now so generally adopted in principle that the results of Prof. Braun's recent experiments, lately published in the *Electrician*, possess great interest, apart from the ingenuity of the method employed. Others have worked, more or less successfully, at the problem of increasing the transmitter energy in wireless telegraphy, but it has been reserved to Prof. Braun to show how the problem can be satisfactorily and economically solved from quite a different direction.

The closed circuit oscillator has the advantage, as is known, of being able to draw upon the kinetic energy in the oscillator circuit, and thus, owing to the fact that such a circuit can be given a much greater capacity than can be obtained with a radiating aerial alone, much more energy can be stored up and radiated by its employment. The emission is also prolonged, both results tending towards the attainment of the much desired train of undamped waves. The energy available, though greater than with the open system, was still inconsiderable unless very high potentials, with the attendant drawbacks, were used. Signor Marconi has adopted this way of increasing the available energy, the potentials attainable by his now familiar arrangement being exceedingly high, but the method is wasteful owing to the length of spark gap used.

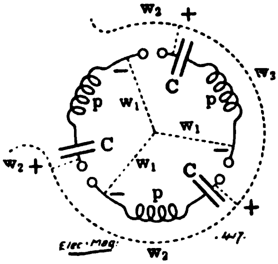


FIG. 1.

Prof. Braun, on the other hand, avoids the use of extremely high potentials for charging the gap and also makes use of a very much less wasteful gap by sub-dividing it—a method described by him some time ago. The chief point in his new arrangement, however, is not the sub-division of the gap merely but their arrangement, by which they are charged in parallel, at low voltages, and discharge in series. He accomplishes this by employing a number of elemental circuits containing capacity and inductance, as shown diagrammatically in Fig. 1. In this, when one gap sparks, the whole circuit closes within itself, thus discharging in series. If the circuit is composed of *n* elements, therefore, the total energy available is *n* times that in a single element, while the period is the same as that of the single element. Prof. Braun has tested this experimentally by taking a system made up of three such elements, as shown in Fig. 2. With this he obtained the same effects (final voltages and heating) simultaneously in three different circuits tuned to one another, and this without any difference in phase. The arrangement of such a multi-elemental system for inductive excitation is shown in Fig. 3, and in Fig. 4 for direct connection.

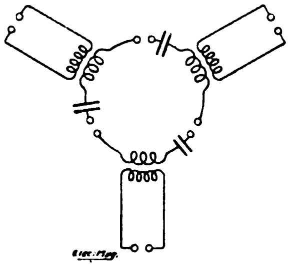


FIG. 2.

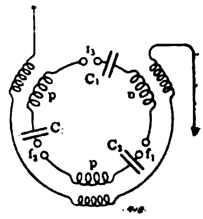


FIG. 3.

The advantage, as before mentioned, lies in the fact that the elements are charged at low voltages, and only connect themselves in series on discharge, and incidentally the use of smaller spark gaps enables the length of the gap to be nearer the most efficient (least wasteful) value, which with a single gap is always greatly exceeded. By this ingenious grouping, the energy of a single system can be increased without having recourse to the wasteful, and otherwise undesirable, very high potential spark gap.

* * *

GOVERNMENT PROPOSAL TO BUY NATIONAL TELEPHONE COMPANY.

BEFORE the Postmaster General decides anything in connection with the proposed purchase of the National Telephone Company's system, we suggest that he ought to avail himself of the experience gained by Corporations working their own systems. The few Corporations bold enough to oppose the Company have proved that it is possible to give a cheap and efficient service. In all towns where Corporations have their own telephone system, the National Telephone Co. has concentrated its best brains, and worked day and night to introduce some of the very latest improvements. Not only has the service been greatly improved, but the rates have been lowered, with the result that, in most cases, the number of telephones has increased threefold, thus making the telephone of much greater value to subscribers. Whatever is stated against competition in telephony, it cannot be gainsaid that the public in the towns owning systems, have reaped great benefits, not only in lower charges—found to be remunerative—but in highly satisfactory modern systems.

The Postmaster General should not lose sight of the fact that recent National Telephone Co. balance sheets have shown that it is possible to build new lines and carry out underground construction at a capital cost per line, approximating that of Corporations.

When the true capital cost per line is arrived at, it is easy to understand local administration makes it possible to pro-

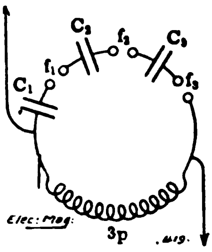


FIG. 4.
(See on previous column.)

fitably work on existing rates as charged by municipalities.

It is the Central or Head Office administration that kills the business. Corporations should be encouraged to own and work their own systems.

If the Government cannot make reasonable terms with the National Telephone Co., it would be far better to let matters take their course until 1911, as was suggested in our March issue, and if in the interval other Corporations do not enter the field, it will at least be proved beyond doubt by those already engaged in the business, that it is possible to work telephones at much lower rates than these hitherto charged by the Company.

The rivalry between engineers and officials responsible for the working of the various systems will ensure progress. By such means will telephony be kept abreast of the times. On the other hand, should Government decide to carry on the work, the past has shown, in the case of the telegraphs, that the development of the business will be retarded. We think that the Postal, Telegraphic and Trunk Telephone work, with the large and constantly agitating staff they employ, is quite enough for the Postmaster General to look after.

ELECTRICAL ANEMOMETER.

THE determination of the amount of wind pressure to the artillerist is the most important of the variable atmospheric elements which affect the flight of projectiles. The pressure exerted by the wind against an obstacle in its path depends upon its velocity and upon the size and shape of the surface against which the pressure is exerted. For artillerists, the rotation anemometer is found to afford better results than a pressure anemometer, because a knowledge of the velocity of the wind is of greater value than any observed pressure, for knowing the velocity, the pressure upon any special projectile under consideration can be determined by a formula. In the United States coast fortifications, the usual hemispherical cups revolving on a vertical rod cause the latter, by aid of a worm thread and wheel, to make an electrical contact and close the circuit of a single stroke bell once every twenty-five revolutions. The bell is in the fire commander's station. By the aid of a stop watch and a chart prepared from an equation determined by Professor C. F. Marvin, the actual velocity of the wind is estimated. The chart, for which we are indebted to the *Electrical Review*, of New York, is here reproduced.

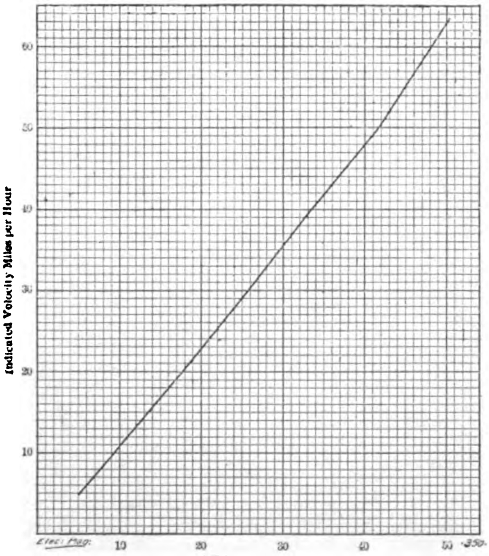
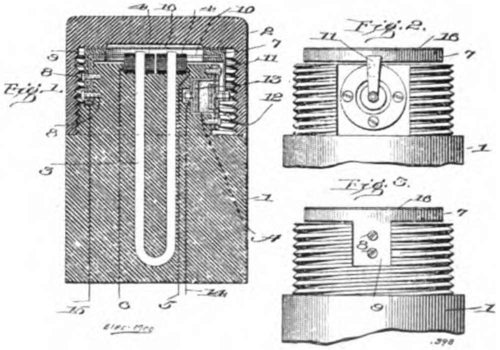


CHART OF ELECTRICAL ANEMOMETER.

ANOTHER TELEPHONE REPEATER.

THE drawing shows a recent invention, a telephone repeater designed on somewhat novel lines. The circuit *15-14*, which contains a microphone *12*, and an induction coil (not shown) is bridged across the line; and the circuit *6-5*, containing the receiver coils *4*, is bridged in shunt with circuit *15-14*. The inventor lays much stress on his method of supporting the diaphram *16*. One side *9* is secured rigidly by a lug as shown in Fig. 3, while a lug from the other side bears upon the electrode button of the microphone *12* (Fig. 2). *16* is the iron diaphram and *7* is a hard rubber ring supporting it. Current is conducted through the metal ring *8* to the microphone. Variations in the field of *4* and *4* cause vibrations of *16*, which are transmitted by means of *11* to the microphone *12*.



TELEPHONE REPEATER.

TELEPHONE NOTES.

Telephones in Hospitals.

THE King Edward Sanatorium for contagious diseases, in Guernsey, in addition to being connected to the States telephone exchange system, is now fitted with light portable hand telephones, so arranged that the nurses can carry them to the bed of any patient, enabling conversations to be held between patients and friends in any part of the Island. The isolation of certain diseases being compulsory, it is some comfort to the patients and their friends to be able to converse with each other without fear of infection. The installation has been a great success, and the little patients, especially, are very grateful and look forward daily to hear Mamma or Daddy's voice during their enforced absence from home.

Some Interesting Party Line Figures.

In connection with the recent agitation, in the United States, in favour of party lines and measured service, some interesting figures and data have been brought out. The following table shows the income per line for some of the largest companies where there are one, two, and four subscribers on the line.

	BUSINESS.			RESIDENCE.		
	1 party	2 party	4 party	1 party	2 party	4 party
Baltimore Independent	$48	$84	$128	$36	$60	$96
Louisville Bell	96	156	192	60	96	120
St. Paul Bell	84	144	216	60	96	144
Pittsburg Bell	125	200	320	100	160	240
Omaha Bell	...	...	...	66	96	144
Milwaukee Bell ...	96	144	240	60	96	144
Kansas City Bell ...	97	150	204	72	120	168

Another interesting party line table is the following. The dividend earning qualities of party lines are made most obvious by these.

No. of Stations per line.	Average Cost per Line.	Rental per Line per Year.	Cost to Operate per Line.	Interest on Investment per Line.	Depreciation Ten per cent per Line.	Total Cost to Operate, Interest and Depreciation per Line.	Net Earning per Line.	Net Earning per Station.	Net per cent. Earned on Investment per Line.
1	$100.00	$48.00	$15.00	$ 5.00	$10 00	$30.00	$18.00	$18.00	18
2	125.00	36-72	22 50	6.25	12.50	41.25	30 75	15 62	24+
4	175.00	27-108	37 50	8 75	17.50	63.75	34.25	11.06	25+
		24-96					32 25	8.03	18+
8	275 00	20-160	67.50	13.75	27.50	108.75	51 25	6 41	18.6
		18-144					35 25	4.40	13·

Municipalities and Telephones.

Since our March issue very little time has been lost by municipalities owning telephone systems, in meeting to discuss the likely effect on such undertakings if the Government decide to purchase the system of the National Telephone Co. A meeting took place at the Westminster Palace Hotel, on April 11th, and representatives were present from Glasgow, Guernsey, Portsmouth, Swansea, Brighton, and Hull. Sir John Ure Primrose, Bart., Lord Provost of Glasgow, occupied the chair, and after the representatives had stated their views the meeting resolved as follows :

1. That the Corporations here represented should not object to the Postmaster-General acquiring the National Telephone Company's undertaking if it can be purchased on such fair and reasonable terms as will bring telephonic communication within the reach of the general community.

2. That all Town and County Authorities should, if they so desire, be allowed and encouraged to own and work telephones within their districts.

3. That the Government should continue to own and work, and should greatly develop, the trunk system of telephones; and should also own and work local telephones in places where the District Authority does not desire to do so.

4. That an interview should be asked at once with the Secretary of the Post Office to secure that, before any Agreement is entered into with the National Telephone Company, an opportunity be afforded the Municipal Corporations of stating their views to the Postmaster-General.

5. That steps should be taken to secure that, in the event of Parliament appointing a Committee to consider the negotiations between the Postmaster-General and the National Telephone Company, the Municipal Corporations should be enabled to lead evidence before that Committee.

Thereafter it was unanimously agreed :—(1) That this Meeting be adjourned until the representatives present have been able to report to their Corporations; and (2) That meantime an Executive Committee be appointed, consisting of two representatives of each of the Corporations, to be appointed by them, to watch over the interests of the Municipalities in the light of the discussion of to-day, with power to arrange for the interview with the Postmaster-General.

The next day the Executive Committee had an interview with Mr. H. Babbington Smith, Secretary to the Post Office, who, after listening to the Members of the Committee, promised to lay their views before the Postmaster-General.

Fire in New York Subway Interrupts Telephone Service.

New York is literally undermined with tunnels for the subway railway system now constructing. In some instances it was necessary when driving the tunnels to make changes in the existing conduit systems so that the conduits could be raised above the roof of the subway structure. In places the conduit was removed entirely from around the cable, and as a make-shift protection burlap or builders wool was warpped around the otherwise uncovered lead sheathed cable. In the excavation at the corner of Fulton Street and Broadway, a workman using a gasoline torch, accidently set fire to the burlap of one of these cables. The fire quickly spread to adjacent cable coverings and to the temporary wooden substructure. The burning burlap around the cables quickly melted the lead sheaths and the paper insulation on the conductors. The report goes that 3,000 telephones were put out of commission and the damage amounted to £2,500. The actual amount of inconvenience the fire caused is difficult to estimate, as several of the cables disabled were 300 pair trunk cables to distant exchanges, the burning of which prevented interchange of traffic from the Courtlandt Street exchange to some others. The fire occurred in the district served by Courtlandt. The operators in this exchange witnessed the unusual sight of 3,000 lamp line signals all glowing at once. The melting of the lead sheath and the burning of the cable conductor coverings short-circuited all the lines, the effect being the same as if every subscriber served by that cable had called at the same instant, New York being served exclusively by common-battery lamp signal exchanges. Long distance communication with Boston, Buffalo, New Haven, and Providence was destroyed, these circuits now being carried underground in leaded cables. Immediately after the conflagration a big force of cable splicers were rushed to the spot and a tent built over them to protect the cables. New lengths were spliced in, replacing the burnt portions, and the work was handled with such expedition that very little inconvenience was experienced by the subscribers.

By special arrangements we are now able to present telegraph and telephone news, in this section, from all known countries employing such apparatus.

TELEGRAPH NOTES.

Electric Timing on a Toboggan Run.

ONE of the exhilarating sports which draws a number of English people to St. Moritz and other places in Switzerland, is tobogganing, and in the locality named there is a course over three-quarters of a mile in length, with a slope of one in six or seven on an average. The speed attained has been as high as sixty miles an hour in the steepest parts of the run. An electric timing arrangement has been instituted, and the apparatus, for description of which we are indebted to the *Electrical Review*, consists of a switch with trigger attached to a cotton thread stretched across the course. A line carrying four wires, connects the starting and finishing posts, two of the wires accommodating telephone and two the timing apparatus. When the thread is broken by the toboggan at the start, the corresponding switch sets the chronograph going by aid of an electro-magnet. On arriving at the finish, the rupture of the thread and the resultant movement of the switch there, is caused to arrest the chronograph, the time being then noted by the judges.

A Magneto Telegraph.

ALGACIO FALCONI, of Florence, has brought out an electric telegraph worked by a Morse key and oscillating armature of a magneto. When the key is pressed, a slight movement of the armature, which is coupled to the axis of the key, sends a current impulse in one direction and a reverse current on release. These impulses work a polarised ink-writer at the other end of the line. There seems to be some promise for the success of this apparatus, but the use of such a key must necessarily be more fatiguing to an operator than is the case with simple battery contacts. Still, as batteries may, with Falconi's telegraph, be dispensed with, it may serve for lightly worked circuits.

Police Telegraphs.

THE police station houses throughout the Borough of Manhattan, New York City, will soon be supplied with the most complete telegraph signal system in the United States, says the *Telegraph Age*, and so effective has it already proved that it is impossible for the patrolman to be off his post longer than half-an-hour at a time during the day or night. The signal-boxes are so constructed that when a patrolman reaches either end of his beat he must signal to the station house, where his call is recorded by a patrolman especially detailed to look after the switchboard. By the new system an ambulance or assistance may be summoned in a minimum space of time, and from the fact that a patrolman is compelled to call up from both ends of his beat and that it takes him from twenty minutes to half an hour to cover it, it readily will be seen that the system forces him to patrol regularly throughout his tour of duty.

Telegraph Supplies for Italy.

"WHILE the field does not seem inviting for the sale of American railway and telegraph supplies in Italy," writes the American Consul, at Turin, "I venture to suggest that it would be well for our large manufacturers to send expert agents here to practically view the situation. In other lines of goods, such as sewing machines, cash registers, typewriting machines, sausage grinders, etc., American products have practically the monopoly of the trade. Vigorous efforts, low prices, and long time payments might result in capturing some of the trade in the line of railway and telegraph supplies."

The Taxation of Telegraph Revenues.

A SHORT and straightforward bill, introduced in the Assembly on March 24, directs the State Controller to ascertain how much of the franchise tax paid in 1881 by the Western Union Telegraph Company, and the Stock Telegraph Company, was assessed on capital not employed in New York State; and then to credit that amount to the companies on current or future tax account. The corporation tax law of 1880, amended in 1881, was so construed by the courts, in a test case made up against this particular company, as to exact payment from them of taxes that year on the basis of their property extending all over the country and under the ocean and into foreign countries; instead of upon the basis of their property within the States, as applied to other corporations, including even the telegraph companies in competition with the Western Union. Such an assesement and such a discrimination was not intended by the law. After the law had been construed by the courts to require such an assessment, the Legislature promptly amended it to correct the injustice. The principle applied in that one year in this and the two or three other exceptional cases has been denounced by the Court of Appeals when considering one of these few cases. This year the relief suggested by the Court of Appeals should, in ordinary fairness, be granted at Albany.

New Switchboard of the Postal Telegraph Cable Co. at Boston.

THE switchboard, which is of the latest Skirrow pattern, is mounted upon a handsome oak frame, and is divided into six sections, four of which, having a capacity of 50 wires each, are assigned to the western, southern, eastern and city wires. Another section is occupied by the annunciator board, for use with the leased wire service. This board, according to an account in *The Telegraph Age*, has a capacity of fifty drops. The throwing of a small switch in the office of a lessee, releases a drop and rings a bell, which continues to ring until the switch attendant cuts in on the wire. Still another section is occupied by an elaborate leg board, with a capacity of fifty quadruplexes. Each of these sections is permanently provided with transfer facilities to every other section; and in addition to this, there is a fifty-jack combining board, for increasing the transfer facilities between the several sections.

In the rear of the switchboard is the distributing room, where are eight vertical cable heads with a capacity of one hundred wires each, and a frame work carrying horizontal slate bars fitted with terminals for 9,500 connections. All main line leaders, as well as the leaders from the operating, repeater tables, etc., centre in this room, and find their proper connection with the several sections of the switchboard. In the basement is located a fireproof terminal room, having accommodation for 800 wires. Six hundred wires now enter this room from the underground conduits, and are carried to the distributing room above in cables of fifty wires each.

Record Signalling in South Africa.

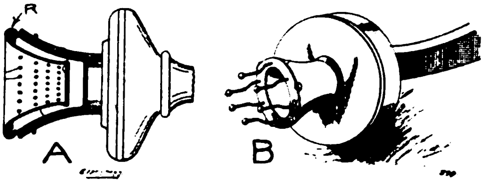
Mr. Cecil Harrison, an ex-Eastern Telegraph Co. operator, has sent 500 words in 11 minutes 46 seconds, and the record on the slip is faultless as regards formation and space. Mr. Richard Harrison, the veteran fast sender, in May, 1894, on the Cape Town-Kimberly line, sent 48½ words per minute for 35 minutes, with only three breaks, a feat which has never been eclipsed in this country, and which he himself has never equalled since. This was reckoned at the rate of five letters to the word, and the slip showed perfect formation of characters, etc., throughout. The date and particulars, also the Morse slip, are preserved in the head offices of the Cape Government Post and Telegraph Department, Cape Town. Mr. R. Harrison is an ex-Royal engineer and Eastern Telegraph Company operator and hails from Dublin, Ireland. There are a number of fast senders and good all around operators in South Africa, but as there are now sufficient lines to cope with any amount of traffic, and Wheatstone is extensively used, fast key work is almost a thing of the past. It is quite possible that a general tournament will be inaugurated in South Africa during the next two years.

New Western Union Office at Philadelphia.

More than 1,500 wires enter the new office to the new plant underground from points outside, distant from 1 to 2 miles. They enter the building in cables from 125 to 200 wires, and laced to the slate board, whence they are connected with the operating room. In addition to the fireproof structure of the entire building, the terminal room is made absolutely fireproof by several extra precautions. The cables that run to the operating room are carried over the roof and sustained by the special trusses which their great weight has necessitated. They are then connected with the switchboards, ten in number, which, as a unit, constitute the largest collection in the United States. Each board receives 100 wires, the remaining wires being used in newspaper service and similar work. The operating room has 214 desks of highly polished oak, while underneath each is a double closet for typewriters. The operators number 210. The ventilation of these quarters is excellent, and while, on the darkest day, no artificial illumination is needed, the light at night is furnished by 256 incandescent electric lamps. 13 motor dynamos, varying in pressure from 6 to 225 volts, furnishes the necessary current. These machines are placed in one end of the operating room, as is the 5 h.p. blower to operate the pneumatic tubes which connect the offices with the receving room, on the ground floor, a distance of about 250 feet.

Antiseptic Telephones.

The above illustrations give some idea of the extent to which the inventive mind can go, or whither it would lead us. A is a telephone receiver with antiseptic mouthpiece, and in B the inventor has made quite sure of his work by placing small studs in the transmitter, to prevent the close approach of the speaker's mouth!



TELEGRAPH TAPPINGS.

The Pollak-Virag.—The experiments with the Pollak-Virag high speed telegraph carried out by the German Government between Berlin and Konigsburg, have been so satisfactory that it is to be applied to the line Berlin to Frankfort. A maximum speed of 40,000 words per hour was obtained with perfect exactitude.

Fibre Tubes Underground.—The Telegraphic and Telephonic Co. of the Pacific States is using, for underground condiuts, tubes made of fibre, paper, and bitumen, which are impermeable to water. The lightness of these tubes saves expense in transport, and they possess the advantage that they contain nothing in their substance which is hurtful to the lead covering of the cables enclosed.

◆

TELEPHONE CALLS.

Telelogue—A New Word.—*Telephony*, of Chicago, Ill., suggests that the word "telelogue" be coined to mean a message by telephone, just as a telegram is a message by telegraph. It is noted that it would be much easier to write the word "telelogue" than to write "referring to our conversation over the telephone."

To Clear Short Circuited Condensers.—It has been suggested that an efficient method to do this is to place the condenser across a 110 volt direct current circuit The short circuit will be burnt out. Care must be taken not to select an alternating current lead, because the condenser would conduct this current readily, and doubtless a dangerous arc would result.

Kempster B. Miller now a Consulting Engineer.—Kempster B. Miller, probably the best known telephone man in the world, he having gained his reputation through writing *American Telephone Practice*, has resigned his position with the Kellogg Switchboard and Supply Co , of Chicago, and has entered consulting engineering with Samuel G. McMeen, who has been connected with the Bell interests. Their offices are in Chicago.

Produce Exchanged Telephonically.—At Penn Yan, New York State, the telephone manager has established a produce telephone exchange. If any of his former line subscribers have anything for sale it is telephoned to the exchange, and noted on a black board, in the switch room, which has been provided for the purpose. Another subscriber may desire to buy the product posted, and will telephone the exchange for information. If there is any possibility of a sale the two traders are put in connection and presumably a bargin is reached. The service is a free one to telephone subscribers.

Underground Cables Not Injured by Fire.—An interesting fact in connection with underground cable construction has been brought out by the recent Baltimore fire. In no case was damage reported to cables in conduit, although the burned district was well covered with underground systems. In Baltimore the conduit system is owned by the city, and all cables are carried in the same one. In the top tier of ducts, two three conductor high tension transmission cables were carried the whole length of the burnt district and they operated continuously at 13,000 volts. It necessarily follows that the telephone and telegraph cables, which were carried in ducts lower down, went through the test unimpaired.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

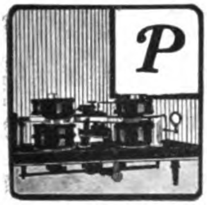
Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable; that coal may absolutely be removed from the ranks of necessary commodities; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

⁂

An Electrolytic Process

For the Production of Parabolic Reflectors for Search Lights.

By SHERARD COWPER-COLES, M.I.E.E.



Parabolic reflectors are extensively used for search lights both for war ships and the mercantile marine, also for military purposes and coast defence. Glass hitherto has been the material mostly employed; all attempts to produce a satisfactory metallic mirror having proved unsatisfactory, until an electrolytic process was devised which enables true parabolic mirrors to be reproduced at a comparatively small cost from a glass mould or matrix having the same degree of accuracy and polish as the glass mould on to which the metallic reflector is deposited and expanded off. A convex cast iron mould having the curvature of a paraboloid is made, from which a concave mould is cast of refractory material. Over this is placed a piece of flat circular glass about ¾ in. thick, and the whole placed in a kiln and heated to such a temperature that the glass will adapt itself to the curvature of the mould without fusing. The mould of glass thus prepared is then ground by emery wheels and finally polished with rouge; the desired curvature being given to a mechanical feed by means of a template or gearing. This process of obtaining a perfect mould forms the main item of expense, one to two months being required with the largest size reflectors. When once the glass mould is made, any number of metallic reflectors can be made from it of varying diameter. When it is desired to produce a reflector, the glass mould is cleaned and the convex surface coated with metallic silver by any of the well known processes for silvering glass. The apparatus employed is illustrated in Fig. 1, where A represents the glass mould, D a sucker for holding the glass, E a pump for exhausting the air from the sucker, F a wood trunnion which allows of the mould being turned over and lowered by means of the screw G into the earthenware vessel H containing the silvering solution.

The silvered glass mould is then placed in a metallic ring and frame, and mounted on a vertical shaft, as shown in Fig. 2, and immersed in an electrolyte of copper sulphate and rotated at about 15 revolutions per minute. When a sufficient thickness of copper has been depo-

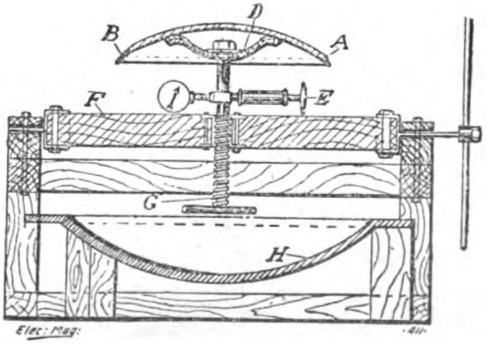


Fig. 1.

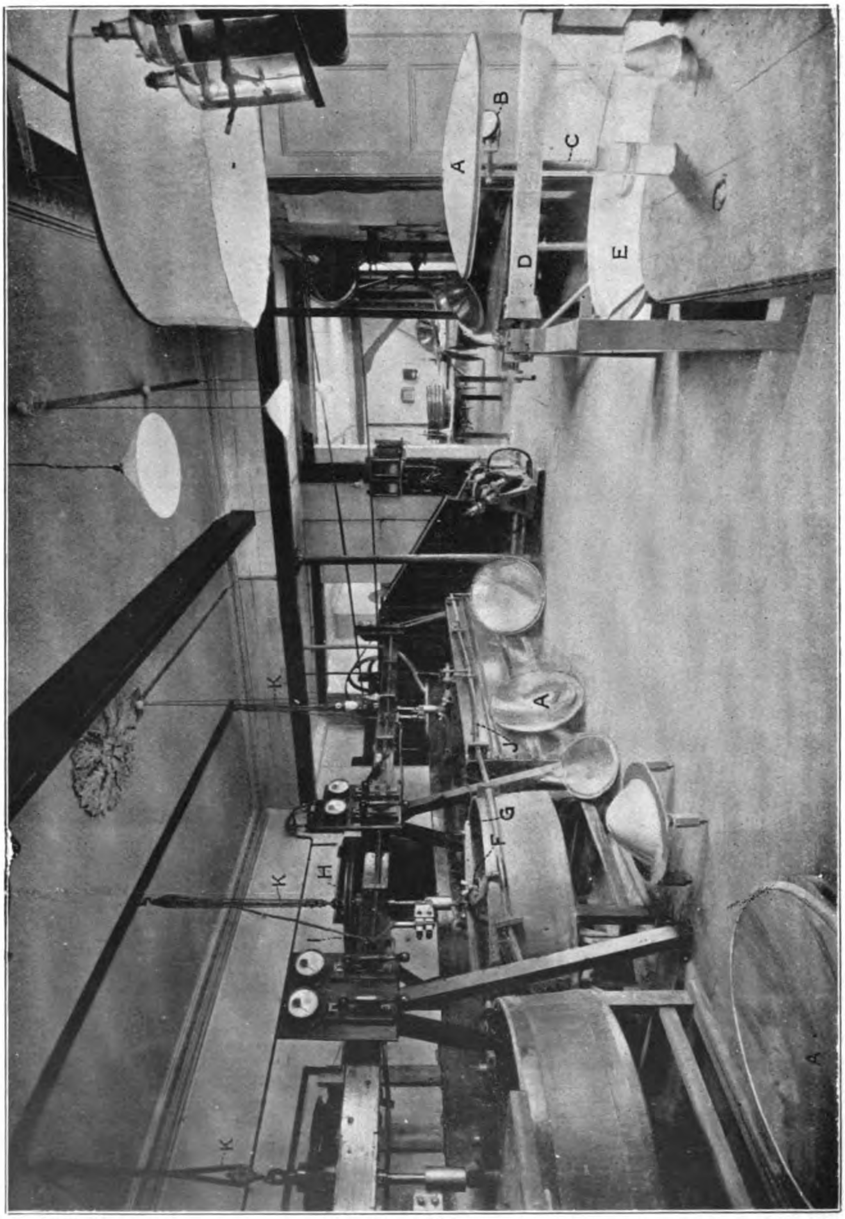


Fig. 3. Plant for Production of Reflectors.

A. *Glass moulds*
B. *Pump for exhausting air from sucker.*
E. *Pan containing silvering solution.*
D. *Trunnion for turning over glass mould.*
C. *Screw for lowering glass mould.*
K. *Blocks for lifting spinning gear.*
T. *Copper conductor.*
F. *Frame for supporting glass mould.*
H. ***Ball-bearing on which spinning gear rotates.***

sited, the mould is removed from the depositing vat and placed in cold water, the temperature of which is gradually raised until a point is reached where, owing to the unequal expansion of the metal and the glass, the reflector leaves the mould. It has a brilliant polish and requires no further treatment other than that of protecting the silver surface from tarnishing. A covering of platinum or palladium serve this purpose, the latter being preferable, although its cost is almost double that of platinum, its specific gravity being but half so, the same area can be covered at relatively the same outlay. Both are deposited electrolytically; palladium from an ammonium chloride solution of palladium, and platinum from a freshly precipitated solution of the double chloride of platinum and ammonium dissolved in a boiling concentrated solution of neutral citrate of sodium. Before being placed in either of these solutions,

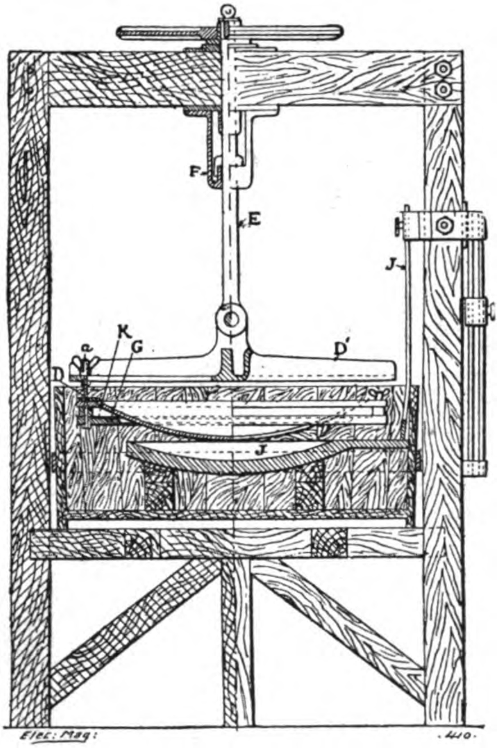


FIG. 2.
(Parabolic Reflectors).

the back of the reflector is usually varnished to prevent local action, and the concave surface thoroughly washed in a weak solution of caustic soda which has been previously heated. When the deposit of platinum or palladium has obtained the desired thickness, the reflector is removed from the bath and dipped in hot water, it is then ready for mounting in a metallic ring for fitting into the projector.

Fig. 3 shows the general arrangement of a plant for producing reflectors for search lights and locomotive head lights. A are the glass moulds, E the silvering vessel, the depositing vats fitted with gear for revolving the glass moulds are on the left, the room in which the copper shells are finally faced with palladium can be seen beyond the depositing room.

AN ELECTRODELESS STEEL FURNACE.

In a paper recently read before the American Institute of Mining Engineers, Mr. F. A. Kjellin described an ingenious electric furnace erected by him at Gysinge, Sweden. He was prompted to introduce the furnace, as experience had shown the difficulties inherent in furnaces employing carbon electrodes, and relying on an arc produced between these and the molten metal. Mr. Kjellin conceived the idea of making a furnace resembling a transformer with a closed secondary circuit formed by the steel to be melted. Fig. 1 shows a cross section of the furnace. An annular grove AA, forms the furnace room, the sides and bottoms of which consist of refractory bricks. The covers BB close the furnace. In the centre of the circle formed by the furnace room is a quadrangular core, C, formed of iron laminations. The coil DD is connected to an alternating current generator. When passing through the coil the current excites a varying magnetic flux in the core, and the intensity of current in the steel is then almost the same as the primary current multiplied by the turns of wire in the primary coil. In this way it is possible to use an A.C. generator of high tension, and yet—without using transformers with copper cables of large sections and costly electrodes—obtain a current of low voltage and great intensity in the furnace. In February, 1900, the first furnace at Gysinge was ready for use, and by March 18th the first steel ingot was cast, which was of an excellent quality. The problem was then solved technically, but not economically, for, with an electric generator of 78 kw., only 270 kg. of steel were produced in 24 hours. The next furnace was completed in November, 1900, and produced, with 57 kw. from 600 kg. to 700 kg. of steel ingots in 24 hours. The charges comprised 100 kg., and the time between the pouring from 3 to 4 hours. The output was not fully satisfactory, because the cooling surface of the walls was too great compared with the contents of the furnace, and the cost of repairs was also rather high. On August 11, 1901, the sulphite pulp mill of Gysinge was completely destroyed by fire, and it was then decided not to rebuild it, but to use the water power formerly absorbed by the pulp mill for steel smelting.

The new plant was ready in May, 1902, and has since then worked satisfactorily. It consists of a furnace containing 1,800 kg. of steel, from which from 1,000 kg. to 1,100 kg. are taken out by each pouring, and the rest left to keep the current passing. The furnace produces, with 165 kw., 4,100 kg. of steel ingots in 24 hours when charged with cold materials. The generator produces alternating single-phase current of 3,000 volts, which is transformed by means of the primary coil and iron core of the furnace into a current of about 30,000 ampères in the steel forming the secondary circuit. The smelting process, as carried on at Gysinge, produces only first - class steel, from the excellent Dannemora pig iron and weld iron. After pouring, about 800 kg. of metal is left in the furnace to keep the current passing, and to this is added the proper quantities of pig iron, bar ends and steel scrap, such as experience has proved will give the percentage of carbon desired in the resultant steel. In pouring there is always less carbon in the steel than that contained in the materials charged, because the pig iron is rusty, and the steel also takes up a little silicon by reduction of the silicic acid of the lining. When the charge is molten and overheated to a suitable degree, the pouring is done in the same way as in the open-hearth furnace, by making a hole in the wall. The upper part

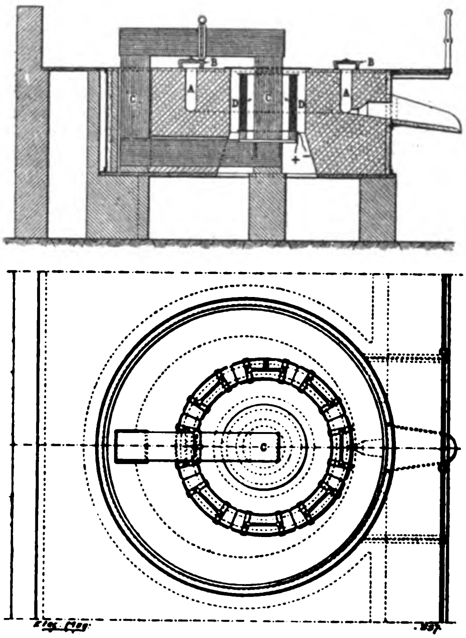


FIG. 1.

of the furnace, as shown in Fig. 1, is on the same level as the working floor, and the charging is done simply by taking off the covers and putting in the materials. As the heat is produced in the steel itself, the slag is not so hot as in other steel furnaces, and consequently the workmen do not suffer much from the heat. The steel produced is, as mentioned above, of an excellent quality, unusually homogeneous, dense and tough, easy to work cold when annealed, and less disposed to crack and warp in hardening than other kinds of steel. The cause of these excellent qualities, apart from the good raw material used, appears to be due to the fact that the product contains less dissolved gaseous matter than other kinds of steel. Even small quantities of gases, especially hydrogen, injure the quality of steel, and the principal cause of the high quality obtained by smelting in crucibles is, in the author's opinion, that the steel is not in contact with the fuel gases, though it may absorb a little through the porous walls of the crucible. In the electric furnace described above, the steel has no opportunity to take up such gases or other impurities, and the quality is even better than that of the crucible steel. To make special steels with nickel, tungsten or chromium offers no difficulties, and the alloys themselves are quite homogeneous. The cost of production depends principally on the efficiency of the furnace and the price of the power. In the furnace now in use at Gysinge the losses have been proved experimentally to be 87·5 kw., so that the effective power absorbed by the steel is $165 - 87{\cdot}5 = 77{\cdot}5$ kw., and, as this produces 4,100 kg. of steel in 24 hours, one effective kilowatt produces 53 kg. of steel ingots in the same time. Every additional kilowatt in the furnace, when the size is not altered, increases the output by 53 kg., and it is calculated that within a few months, when a stronger water wheel is obtainable, it will be possible to produce about 6,000 kg. of steel ingots with 200 kw. As the absolute cost of labour and repair will be the same, the cost for 1 ton of steel ingots will be about two-thirds of the present cost, and the price of power per ton also will be sensibly diminished. At Gysinge the cost of repair (renewing the lining of the furnace when it is worn out) was £15. From experience with this furnace it is calculated that a furnace of 736 kw. will produce 30,000 kg. of steel ingots in 24 hours, when charged with cold materials. With hot materials the output is much greater. For instance, if 250 kg. of molten pig iron are charged for each ton of steel ingots produced, the output is increased from 30,000 kg. to 36,000 kg. in 24 hours with 936 kw. It would seem that the costs of labour and repairs for a furnace of this type will be less than those of an open-hearth furnace of the same size; so that, where power is cheap, there is a possibility of producing a steel competing with the expensive crucible steel at a smelting cost not exceeding that of the open-hearth furnace.

BLONDLOT RAYS.

JUDGING from the recent discoveries published in the *Comptes Rendus*, it looks as if practical applications would soon be found for Blondlot rays, both in the chemical and in the medical branches of science. M. Charpentier finds that most alkaloids, and several other toxics like chloral, emit N rays in considerable quantities, and that when placed near another source they increase its activity, so that the total action on any screen is greater than would be the sum of the separate actions, a fact which can be easily verified experimentally. The author has devised reinforcing screens based on this principle, made by sticking a layer of alkaloid on to a sheet of black cardboard of 10 to 12 cm. surface, with collodion, the central spot of sulphide being about 1 or 2 cm. in diameter. Such screens are found to be endowed with a new selective property, that of being more specially sensitive to radiations from certain organs of the body. Further, the organ which most influences a particular screen, is precisely the one in which the specific action of the alkaloid constituting that screen is more specially localised. Thus digitaline has an elective action on the heart, and a digitaline screen will light up brightly in front of that organ, enabling its shape to be marked out much more easily than with an ordinary screen. This and similar facts were all verified by M. Charpentier, on the organs of a live dog. M. J. Meyer has found that stretched glass or copper wire, a closed glass tube inside which partial vacuum is produced, an incandescent lamp with no current passing through it, a Geissler tube, a Crookes tube not actuated by a Rhumkorff coil, are all sources of N_1 rays. These appear to have great penetrating power, whereas those emitted by a Nernst lamp are easily arrested by interposing a sheet of oxidised lead or wet paper. For instance, the action of an incandescent lamp on a screen is not modified by a board 10 cm. thick, a sheet of oxidised lead 1 cm. thick, folded so as to be traversed 8 times, or a glass vase 10 cm. thick, filled with pure water. Cardboard, paraffin, aluminium, zinc, iron, copper, silver, gold, mercury, and the hand are also transparent; the only opaque bodies found by the author being platinum 1 mm. and opalescent glass 3 mm. thick. An aluminium lens used with N_1 rays stores them up and continues to emit them long after the source is removed. Ordinary and crown glass also store them up, but their emissive power is of comparatively short duration. Lead, copper, and pure water are non-absorbent. The slight moisture on the hands due to perspiration, behaves like a solution of salt and absorbs rays; the operator can thus use his hands as a source.

In a recent communication, M. Colson suggests that N_1 rays may possibly be used for revealing certain chemical re-actions which would otherwise pass unnoticed. When preparing hydrated zinc oxide, he found that the addition of potash to a solution of zinc sulphate gave rise to a momentary emission of N_1 rays, which did not occur if the reverse method were adopted, of pouring the sulphate on to the potash. He attributes this difference to the formation of basic salts in the first case, as if this sort of molecular condensation produced effects similar to those obtained by mechanical compression.

ELECTROPHYSICAL NOTES.

Electric Conductivity in the Field of Electrostatics.

In the *Physikalische Zeitschrift*, April 1st, 1904, Prof. Wladimir de Nicolaïewe arrives at the conclusion that electrostatics in its present form is a fiction. In order to agree with the experimental facts, this science should be transformed, and its formulæ made to include electric conductivity in addition to permeability; the formulæ of electrostriction from which the forces acting on an isotropical dielectric substance are calculated, fail to be of any use when applied to some experiments described by the author.

The Electric Field of Insulators Immersed in Electrolytes.

The experiments made by Prof. Wladimir de Nicolaïewe prove the existence of an electric field in the interior of insulators immersed into conductors of electricity. In accordance with Prof. Cohn's views, this field is limited by the contact surface between the insulator and the electrolyte, while its forces show the properties of internal forces. (*Physikalische Zeitschrift*, April 15th.)

Radioactive Emanation from Water and Oil Fountains.

In a paper published in the *Physikalische Zeitschrift*, April 15th, 1904, Prof. F. Himstedt arrives at the conclusion that radioactive bodies giving off a gaseous emanation are widely diffused throughout the earth; these emanations are absorbed by water (or by petroleum) and after being conveyed along with the latter to the surface of the earth, will thence diffuse into the air. Because of the many analogies noted between these emanations and radium emanations, the author thinks it possible that both are identical. In this case, the ores of uranium, from which radium emanations are derived, would either be widely diffused, or else there would be some further matters possessing, though to a lesser degree, the property of giving off emanations. Considering that the absorption co-efficient of water as well as of petroleum with respect to this emanation, is found to decrease for increasing temperatures, while hot fountains, on the other hand, show an especially high activity, the hypothesis is suggested that the amount of radioactive mineral is increasing for augmenting depths, and according to Curie's observation as to the continual heat evolution from radium, the radio-active components of the earth should possibly have to be allowed for in accounting for the temperature of the earth.

On Electrodeless Annular Currents.

In the *Physikalische Zeitschrift*, April 1st, 1904, Mr. E. Lecher shows J. J. Thomson's electrodeless annular current to be produced in the following way:—

1. Between the ends of the coil there arises a large oscillating potential difference due to impedance, resulting in a reciprocating flow of electricity in the vacuum, in addition to the strong ionisation of the gas.
2. This luminescence is thrown towards the edge, by the magnetic forces of the coil.
3. There is likely to occur a further increase of the luminosity, due to the induction currents proper, which however may exist only in gases of specially high ionisation.

The Measurement of Magnetic Constants.

M.M. Curie and Chèneveau have invented an instrument for measuring magnetic constants, and more especially specific co-efficients of magnetisation. The apparatus comprises a torsion balance, with which the force acting on a body placed in a non-uniform magnetic field is measured. A ring shaped magnet creates the field, and its position can be varied relatively to the substance under experiment. For measuring the deviation of the torsion balance, a microscope and micrometer are used. Radium chloride was found to be paramagnetic. Taking the magnetism of air into account, and supposing the co-efficient for water to be $\cdot 79 \times 10^{-6}$, that for radium chloride would be $\cdot 95 \times 10^{-6}$.

Leclanche Dry Cell.

By an ingenious modification of the Leclanché type, an element can be constructed which has good staying qualities, and is absolutely free from leakage. Electrodes and electrolyte are shut up in a wooden box, which is coated internally with a resinous insulating substance, this being also used for sticking a canvas covering on the outside of the cell. The positive element is constituted by two cylindrical carbons, which are surrounded by a depolarising mixture of retort carbon and manganese dioxide, contained in two canvas bags. To each electrode is fixed a rod, which pierces the cover and is joined to its neighbour by a piece of tinplate. A spiral of paraffined string keeps the bags isolated from three strips of amalgamated zinc which separate them, forming the negative electrode. The electrolyte is a solution of ammonium chloride, which at the ordinary temperature is solidified into a jelly-like mass, by the addition of gelose or Japanese glue. This is the type of cell in use at the French Post Office, and the following are some of its characteristics;—

Dimensions	120 × 185 × 245 mm.
Weight ...	7·2 kg.
El. force ...	1·53 v.
Resistance	150 ohms.

Output when left for 30 days in a circuit of 5 ohms. resistance: 150 a.h.

Ditto when left in the same circuit till the potential has fallen to ·80 volts; 160 a.h.

On the Pressure exerted on the Electrodes of an Electric Spark.

At a recent meeting of the Russian Physico-Chemical Society, K. K. Baumgart presented a communication on an interesting phenomenon. The author observed in electric sparks a pressure acting on the cathode; the spark was produced by a Rhumkorff coil. For spark lengths of about 1 m/m this pressure was upwards of 1 m/m of water column; for increasing spark lengths, this pressure was found to decrease, the above length of 1 m/m appearing to correspond to a maximum. On the anode a small positive pressure is in turn observed, though this phenomenon be not regular, secondary phenomena apparently exerting a disturbing influence. Baumgart does not think it possible to account for the phenomenon observed on thermical phenomena or those of capillary electricity. Considering the electric spark as an anode flux seems to afford the most rational explanation; on this hypothesis the author calculates the coefficient $\frac{\epsilon}{\mu}$ and v, the figures thus obtained (viz. 10^5 and 10^8 respectively) being in satisfactory accord with the values obtained by Mr. Wien for anode rays.

The phenomenon observed by Baumgart shows a reciprocal behaviour to the one observed by Dewar and Mitkiewicz on electric arcs. A. G.

Conduction of Electricity in Flames.

In a paper read at a recent meeting of the German Physical Society, Dr. H. Starke recorded his views on the phenomena of the conduction of electricity through flames. In the flame proper, containing two non-incandescent electrodes, ionisation occurs throughout the volume of the flame, instead of on the surface of the electrode, the high velocity of negative ions resulting in the potential fall being chiefly confined to the cathode. Now, the fact that the current traversing the flame for higher E.M.F.s is made up of two portions—one being independent of, and the other proportional to, the E.M.F.—has been put forth as an evidence of the incorrectness of the above views. This apparent contradiction is accounted for by the following hypothesis: Let the state of saturation exist throughout the conducting space only at the moment of first applying the potential difference; as soon as the distribution of potential confining nearly the whole of the potential fall to the cathode is obtained, a state of saturation will exist only in the neighbourhood of the cathode where the ions exhibiting a small density will move with an extreme rapidity, while in the remainder of the space re-combination of the slowly moving ions may take place. On this hypothesis, the current traversing the flame—*e.g.*, the stream of positive particles directed towards the cathode—would comprise, first, any positive particles generated within the high cathode fall (saturation current of that portion); and, second, part of the positive ions generated outside of this position, being the non-saturated current of the remaining flame space. The latter portion would increase along with the E.M.F. applied.

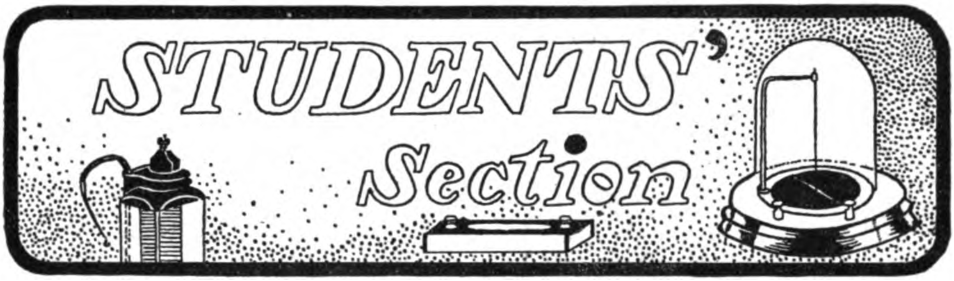
Dielectric Capacity of Atoms.

Two communications, by W. Sutherland, dealing with this subject, appear in the April number of *The Philosophical Magazine*.

In the first of these some interesting suggestions are made with a view of explaining the marked deviation of the halogen atoms from Maxwell's law of refractive indices. In these atoms, the dielectric capacity, instead of being equal to the square of the refractive index, is invariably proportional to the square. In all cases, however, it appears that the dielectric capacity of an atom is directly proportional to the valency and inversely proportional to the square root of the volume of the atom. From this, by the aid of results obtained in a previously published investigation, the conclusion is arrived at that a certain stock of electric energy associated with the electrons in an atom is the same for all atoms. Another consequence is that the ionic velocity of an atom is directly proportional to the square root of its radius, which explains the different velocities of various ions in a resisting medium and in the action of driving forces which were assumed to be equal. The forces were not, in reality, equal, owing to no account having been taken of the dielectric capacities of the several atoms. In the second communication it is shown that the consideration of of the dielectric capacities makes it impossible to regard an electrolytic current as consisting solely of the waftage of electrons by atoms. This must be accompanied by an ether displacement which is shown to be of exactly the amount required by Fresnel's theory that the velocity of the ether in a moving transparent body is $1-1/\mu^2$ of that of the body, whose index of refraction is μ. It is pointed out that phenomena occurring in ionisation afford an electrical example of Fresnel's law, and the Crémieu-Pender effect is another example. The author considers that experiment tends to support the theory that the magnetic effect of electric convection is due to the slip between electricity and ether, rather than that which represents it as the result of the relative motion of electricity and remote ether.

Double Refraction in Matter Moving through the Ether.

D. B. Brace, in *The Philosophical Magazine* for April, describes some experiments made to test the validity of the Fitzgerald-Lorentz contraction hypothesis as an explanation of the negative results of the Michelson-Morley experiment on the interference of rays respectively parallel and perpendicular to the direction of the earth's motion. The author's conclusion is that, either the ether is carried along with the moving matter, or the effect of the relative motion on the intermolecular faces, with the resulting possible change of dimensions, is very small.



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of *The Electrical Magazine* feels that something more is wanted, and the Associate Editors, will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

* * *

Problems in Dynamo Design.—III.

By ELLIS H. CRAPPER, M.I.E.E.

HEATING OF COILS.

As is well known, the temperature of a conductor increases when traversed by a current, and electrical resistance varies considerably with temperature changes. In other words, the specific resistance of metals increases slightly with increase of temperature, and the percentage increase in resistance per degree rise in temperature is known as *temperature coefficient*. Experiments prove that the variation in resistance with changes of temperature may be expressed as follows:

$$R_t = R_o\,(1 + at + \beta t^2)$$

where R_o is the resistance at 0° C., R_t is the corresponding resistance at the temperature $t°$, and a and β are coefficients depending upon the material of which the conductor is made. For copper, Messrs. Clarke, Forde, and Taylor give the following values of a and β, according to the scale of temperatures used:

Centigrade Scale—

$$R_t = R_o\left\{1 + 0{\cdot}00426744t + 0{\cdot}0000011193t^2\right\}$$

Fahrenheit Scale—

$$R_t = R_{32^\circ}\left\{1 + 0{\cdot}0023708[t-32] + 0{\cdot}00000034548[t-32]^2\right\}$$

For ordinary practical purposes, however, the usual expression for the temperature-resistance variation of metals and alloys is

$$R_t = R_o\,(1 + at),$$

in which case $a = 0{\cdot}004284$ for the Centigrade scale, and $a = {\cdot}00238$ for the Fahrenheit scale. If the rise in temperature of a field magnet coil be known, then the increase in resistance may be calculated as follows: Let t_1 denote the temperature of the coil when cold, say 15°, and t_2 the higher temperature of the coil when warm, then

$$R_{t_1} = R_o\,(1 + at_1)$$

$$R_{t_2} = R_o\,(1 + at_2)$$

and $$R_{t_2} = R_{t_1} \times \frac{1 + at_2}{1 + at_1}$$

Example 1. It is required to find the resistance at 60° C. (warm) of a shunt coil of 3,050 turns of No. 16 S.W.G. copper wire, the mean length of one turn being 5·21 ft., the resistance of which at 15° C. was 39 ohms.

Using the general formula $R_{t_2} = R_{t_1} \times \frac{1 + at_2}{1 + at_1}$ we have

$$R_{60} = R_{15} \times \frac{1 + {\cdot}004284 \times 60}{1 + {\cdot}004284 \times 15}$$

$$= 39 \times \frac{1{\cdot}25704}{1{\cdot}06426}$$

$$= 46{\cdot}06 \text{ ohms.}$$

The common method of measuring the warm temperature of a field magnet coil, by laying upon the surface the bulb of a thermometer covered with a pad of cotton wool, is only an approximate method, and does not give the average temperature of the interior. A much better method of finding the rise of temperature internally is to calculate the rise from the observed increase of resistance. Thus, using the general equation given above, we have:

$$\frac{R_{t_2}}{R_{t_1}} = \frac{1 + at_2}{1 + at_1}$$

and $$1 + at_2 = \frac{R_{t_2}}{R_{t_1}} \times (1 + at_1)$$

$$\therefore\ at_2=\frac{R_{t2}}{R_{t1}}(1+at_1)-1$$

and $$t_2=\frac{R_{t2}-R_{t1}}{aR_{t1}}+\frac{t_1R_{t2}}{R_{t1}}$$

Note, increase of temperature is t_2-t_1.

Example 2. What rise of temperature will cause the resistance of a field magnet coil to increase from 39 ohms at 15° C. to 46·75 ohms when warm?

Substituting the given values in the above equation, we have

$$t_2=\frac{46{\cdot}75-39}{{\cdot}004284\times 39}+\frac{15\times 46{\cdot}75}{39}$$
$$=46{\cdot}4+17{\cdot}98=64{\cdot}38^\circ\text{ C.}$$

Temperature increase $=64{\cdot}38^\circ-15^\circ$
$=49{\cdot}38^\circ$ C.

Example 3. The limb of a dynamo magnet is of square section, each side measuring 8 in.; the length of the portion occupied by shunt winding is 7 in. What size and quantity of wire will be required to form a shunt coil which will give 12,000 ampère-turns when a pressure of 100 volts is maintained between its two ends, and allowing a cooling surface of 2 sq. in. per watt wasted? The cooling surface may be taken as the area of the external surface of the coil, plus that of the two ends. The resistance of a cubic inch of copper is approximately 0·66 microhm at 60° Fahr., and the coefficient for increase of resistance with rise of temperature 0·21 per cent. per degree Fahr. The working temperature of the coil is to be taken at 110° Fahr. (City and Guilds, Electric Lighting and Power Transmission.)

The section of the magnet limb is shown in Fig. 1 by the full line portion, and the part occupied by the shunt winding is indicated by the broken line. Let the depth of this winding be h inches; the number of turns of wire, S, of diameter d mils occupying the space indicated will be

$$\left.\begin{aligned}S&=\frac{1000h}{d+14}\times\frac{7000}{d+14}=\frac{7\times 10^6h}{(d+14)^2}\\&=\frac{12000}{C}\end{aligned}\right\}\ -\ -\ -\quad (1)$$

since CS = 12000 ampère turns.

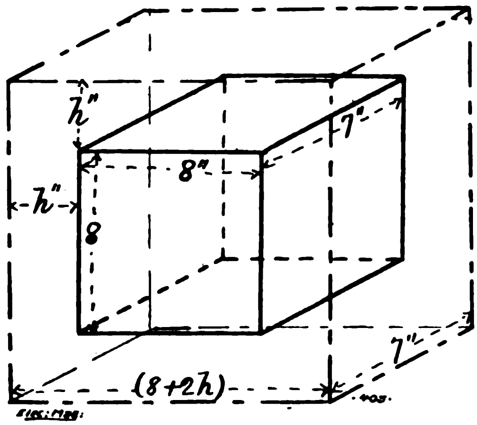


FIG. 1.

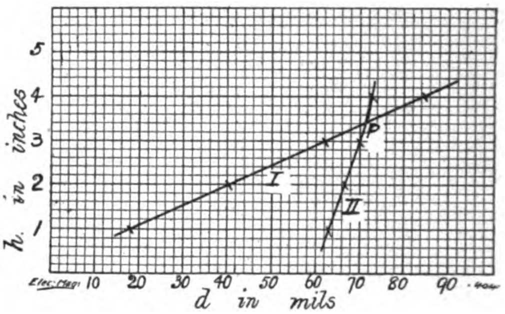


FIG. 2.

If V_s = the volume of the space occupied by the coil,

$$\left.\begin{aligned}V_s&=Sl_m\left(\frac{d+14}{1000}\right)^2\\&=7[(8+2h)^2-8^2]=28h(8+h)\end{aligned}\right\}\quad (2)$$

where l_m = mean length of a turn in inches
$=4\ (8+h)$

and 14 mils is allowed as the increased thickness of the wire due to insulation, therefore

$$Sl_m\frac{(d+14)^2}{10^6}=28h\ (8+h)$$

and $$S\frac{(d+14)^2}{10^6}=7h\ -\ -\ -\ -\quad (3)$$

If w = watts wasted by heating, we have

$$w=EC=100\text{ C}\ -\ -\ -\ -\ -\ -\ -\ -\ -\quad (4)$$

but the area of cooling surface A_c is

$$A_c=4[7\times(8+2h)]+2[(8+2h)^2-8^2]$$
$$\left.\begin{aligned}&=8\ (h^2+15h+28)\\&=2w\ \text{(per question)}\end{aligned}\right\}\ -\ -\ -\ -\quad (5)$$
$$\therefore\ 2\ (100\text{ C})=8\ (h^2+15h+28)$$

and $$C=\frac{1}{25}(h^2+15h+28)$$

$$\therefore\ S=\frac{12000}{C}=\frac{12000\times 25}{(h^2+15h+28)}$$

and equation (3) becomes

$$7h=\frac{12000\times 25}{(h^2+15h+28}\times\frac{(d+14)^2}{10^6}$$

and $$7h\ (h^2+15h+28)=\frac{3}{10}(d+14)^2\ -\ -\quad (6)$$

Now, the resistance of a mil-foot of wire at a temperature of 110° F. is, per question,

$$r=\frac{{\cdot}66}{10^6}\times\frac{12}{(\frac{1}{1000})^2\times{\cdot}7854}\times[1+{\cdot}0021\ (110-60)]$$
$$=11{\cdot}14\text{ ohms,}$$

and the diameter of the wire to use to satisfy the conditions of the problem may be calculated from the formula $d\ (\text{mils})=\sqrt{\frac{r\,CSl_m}{E_m}}$ (see page 296 of *The Electrical Magazine*, March, 1904).

$$\therefore\ d=\sqrt{\frac{11{\cdot}14\times 12000\times\frac{4}{12}(8+h)}{100}}$$

$$\left.\begin{aligned}\therefore\ d^2&=445{\cdot}6\ (8+h)\\ \text{or}\quad h&=\frac{d^2}{445{\cdot}6}-8\end{aligned}\right\}\ -\ -\ -\ -\quad (7)$$

Equations (6) and (7) give the connection between the size of the wire, d, and the depth of the winding, *h*, by solving which the size of wire to use is determined. Since the cube of *h* occurs in equation (6) the graphical solution is given, which is obtained by plotting the curves for equations (6) and (7), as shown in Fig. 2, and the point of intersection, P, of the curves gives directly the values of *d* and *h* required. The curves have been obtained by calculating the values of *d* for different values of *h*, as indicated by the following table:

When *h* is	*d* is	
	from equation (6)	from equation (7)
1 inch	18 mils	63·3 mils
2 inches	40 ,,	66·7 ,,
3 ,,	62 ,,	70·0 ,,
4 ,,	84 ,,	73·0 ,,

In Fig. 2, curve I. corresponds to equation (6) and curve II. to equation (7), and it will be observed that the point of intersection, P, gives $h = 3{\cdot}4$ in. and $d = 71{\cdot}25$ mils. As a check upon these figures, we may now determine whether the condition of a cooling surface of 2 sq. in. per watt wasted is satisfied by these values. By substituting 3·4 in. for *h* in equation (5) we have

$$A_c = 8[(3{\cdot}4)^2 + 15 \times 3{\cdot}4 + 28]$$
$$= 724.5 \text{ sq. in.}$$

From (1) the number of turns forming the coil is

$$S = \frac{7 \times 10^6 \times 3{\cdot}4}{(71{\cdot}25 + 14)^2}$$
$$= 3275$$
$$C = \frac{12000}{3275} = 3{\cdot}664 \text{ ampères}$$

and watts wasted is $w = CE = 3{\cdot}664 \times 100$

$$= 366{\cdot}4 \text{ watts}$$
$$\therefore \frac{724{\cdot}5}{366{\cdot}4} = 1{\cdot}97 \text{ sq. in. per watt.}$$

The quantity of wire required is readily found by taking the product of the number of turns, S, and the mean length of a turn, l_m; thus

$$\text{total length of wire} = Sl_m = S[4(8+h)$$
$$= 3275 \times 4 \times 11{\cdot}4 \text{ in.}$$
$$= 4149 \text{ yds.}$$

The nearest gauge of wire for a diameter of 71·25 mils is No. 15, which has a diameter of 0·072 in.

Electric Traction Problem. An electrically driven railway train, weighing 100 tons, travels 10 miles along a line which rises 600 ft. in the distance, the tractive force on the level being 12 lbs. per ton. Find the number of kilowatt hours required to do the work, efficiency of motor and gearing being taken at 82 per cent. (City and Guilds, Electric Lighting and Power Transmission, 1903).

This example is inserted to show how to change from one system of units to another, which frequently offers considerable difficulty to young students.

The work done in travelling 10 miles on the level $\Big\}$ $= (100 \times 12) \times (10 \times 1760 \times 3)$

$= 63360000$ foot pounds

work done in raising the train vertically 600 ft. $\Big\}$ $= (100 \times 2240)\ 600$

$= 134400000$ foot pounds

total work done $= 63360000 + 134400000$

$= 197760000$ foot pounds

Since the efficiency is 82 per cent., the number of foot pounds expended $= 197760000 \times \frac{100}{82}$ ft. pnds.

Now, 1 kilowatt hour $= 1000$ watt hours

$= 1000 \times 3600$ joules

$\therefore \frac{1}{36 \times 10^5}$ kw. hour $= 1$ joule

and 1 h.p. $= 746$ watts

$= 746$ joules per second

$= 550$ foot pounds per sec.

$\therefore$ 550 foot pounds $= 746$ joules

$$\therefore \frac{19776}{82} \times 10^6 \text{ ft. pnds.} = \frac{19776 \times 10^6}{82} \times \frac{746}{550} \text{ joules}$$
$$= \frac{19776 \times 10^6 \times 746}{82 \times 550 \times 36 \times 10^5} \text{ kw.hrs.}$$
$$= \frac{19776 \times 746}{82 \times 55 \times 36} = 90{\cdot}86 \quad ,,$$

* * *

THE FOUNDATIONS OF ELECTROMAGNETISM.

By ALFRED HAY, D.Sc., M.I.E.E.

(Concluded from page 411.)

THE next two propositions which we shall consider are of such paramount importance, that they may fairly be said to dominate the entire field of both the theory and practice of electrical engineering.

THEOREM REGARDING M.M.F.

Take any closed path, such as A B C D, and subdivide it into numerous short "elements," each element being so short that it may be regarded as practically straight, and the magnetic force H as having a constant magnitude and direction at all points of the element. The magnetic force, in reality, varies in a continuous manner as we proceed around the closed path; but if our elements are made sufficiently short, we may substitute, for

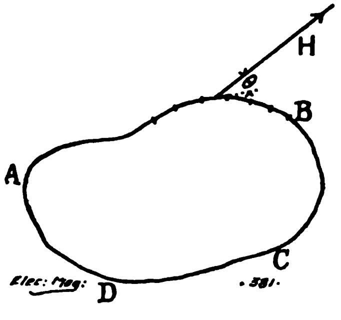


FIG. 1.

the continuous variation, a step-by-step variation as we pass from one element to another; the steps, however, being so very small as to be indistinguishable from continuous variation. Let the angle made by the direction of the magnetic force with the direction of the element be θ, so that the component of the magnetic force along the element is H cos θ. This is, by the definition of magnetic force, the force *along the element* which would act on a unit magnetic pole placed at any point of the element. Hence if we multiply H cos θ by the length of the element, we obtain the *work done* in moving a unit magnetic pole from one end of the element to the other if the direction of motion is against the magnetic force, or the *work gained* in allowing the unit pole to move from one end to the other of the element, the motion being now in the direction of the force acting on the unit pole. Let the product in the last case be considered positive, and in the first negative, and let the sum be taken of all such products for the various elements into which the closed path has been divided, care being taken to assign the proper algebraical sign to each product. The algebraical sum of the products clearly represents the work gained in allowing a unit magnetic pole to describe the closed path A B C D, and it is defined as the *magnetomotive-force*, or, briefly, M.M.F. around the closed path.

If the closed path passes partly through magnetic, and partly through non-magnetic media, then in considering that part of it which lies in the magnetic media, we must be careful to take the *magnetic force* (and not the magnetic induction) in forming our products. *The theorem regarding M.M.F. states that in every possible case the M.M.F. around any closed path is equal to 4 π times the total current, in C.G.S. units, linked with the path.*

This theorem forms the scientific foundation for the design of electro-magnets of various types. An electro-magnet is generally required to produce a definite magnetic flux through a definite area. Assuming a certain shape and size for our electro-magnet, we can, in most cases with a high degree of accuracy, determine the values of the magnetic induction B along the various portions of a closed curve, which is chosen so as to follow, as nearly as possible, the *mean path* of the lines of induction. If now the magnetic qualities of the various materials are known—*i.e.*, the relation connecting B with H—then we can find, by reference to the B-H curve, the valves of H along the various portions of our closed curve, and so determine the corresponding products of H into the respective lengths of curve. The sum of such products gives us, by definition, the M.M.F. around the curve.

We next apply the theorem regarding M.M.F., thus obtaining the total current linked with the curve. In most cases, such linkage of current with the closed curve is obtained by the use of a coil, each of whose turns is linked with the curve, the total linkage being equal to the product of the number of turns S in the coil into the current flowing through it. If we measure the current in ampères, the linkage of current, in C.G.S. units, will be one-tenth of the product of the ampères into the turns, or one-tenth of the *ampère turns* (which is the usual term employed for this product). We thus get the well-known and important relation

$$\text{M.M.F.} = \frac{4\pi}{10} \text{ or } 1{\cdot}257 \text{ times the ampère-turns,}$$

or

$$\text{ampère-turns} = \frac{1}{1{\cdot}257} \text{ or nearly } {\cdot}8 \text{ times the M.M.F.}$$

As regards the actual *proof* of this theorem, although a fairly simple elementary demonstration of it may be given, yet by far the most convincing and satisfactory evidence of its truth is to be found in the fact that results deduced by its aid have always been found to agree with experiment.

THEOREM REGARDING E.M.F.

Here we again have to deal with a closed curve, and to consider the work gained when a unit electric quantity (instead of, as in the previous case, a unit magnetic pole) is allowed to pass around the curve. The work gained is defined to be the electromotive-force, or E.M.F., around the closed curve. Such an E.M.F. might, for example, be produced by a primary cell, which forms part of the closed path. We shall suppose, however, that such purely chemical sources of E.M.F. do not exist in the case we are considering, but that the E.M.F. around our closed curve is *induced by a varying magnetic flux*. The fact that a varying magnetic flux is capable of giving rise to an E.M.F. in any circuit with which it (the flux) is linked was discovered in 1831 by Faraday, in England, and simultaneously by Henry, in the United States, and constitutes one of the chief claims of these investigators to scientific fame. The quantitative relation connecting the value of the induced E.M.F. with the rate at which the magnetic flux changes is of the simplest possible kind, namely,

Induced E.M.F. = rate of change of magnetic flux.

If, as is usual, the magnetic flux is expressed in C.G.S. units, then in order to obtain the E.M.F. in *volts*, the rate of change of the flux must be divided by 10^8.

The theorem regarding the induction of E.M.F. by a varying magnetic flux underlies the design of armatures, transformers, etc.—in fact, it has to be made use of in every case in which we have to deal with the design of apparatus for either the generation or the transformation of electrical energy.

We have now completed our brief survey of the various principles which form the foundations of the modern science of electromagnetism. The ramifications of electrical science are so great, and the mass of experimental data so overwhelming, that a novice frequently runs the risk of losing sight of the great foundations of the science in his pursuit of its details. To the student of electrical science, it is of the utmost importance to recognise clearly the great principles to which appeal has to be made in dealing with any either purely scientific or purely technical matter. For it may be pointed out that the pure theorist is quite as much dependent on the great principles we have passed in review, as the engineer whose business it is to design electrical machinery.

ROTARY CONVERTERS.

Among the various types of machines which it is the lot of the electrical engineer to study, few present a greater amount of interest than those remarkable combinations of a motor and a generator in a single machine known as "rotary converters." The term "converter" is an old one, but it is only comparatively recently that its meaning has been specialised. In the early days of electric lighting, the term "converter" was used as a synonym for "transformer." When the rotary converter made its first appearance, it was sometimes spoken of as a "rotary transformer," and in order to prevent confusion some of our American cousins even now speak of "static transformers" where we should use the term "transformers" simply.

A rotary converter is—apart from certain peculiarities in its design, necessitated by its peculiarities of behaviour—practically a continuous-current dynamo of the standard type, with the addition of a number of continuous contact-rings or "slip-rings," mounted on the shaft but insulated from it, and connected to certain points in the armature winding. The student who has studied continuous current dynamos will have no difficulty in proving for himself that if two diametrically opposite points be taken in the winding of a two pole machine, and connected to two slip-rings, then an alternating P.D. will be obtained between the slip-rings during the rotation of the armature. If four points 90° apart be taken, and connected to four slip-rings, then between rings corresponding to a pair of diametrically opposite points we obtain an alternating P.D. which is displaced by 90° as regards *phase* relatively to the P.D. between the remaining pair of slip-rings. Such a system of two alternating currents differing 90° in phase forms a *two-phase* system. A *three-phase* system of currents might be obtained by choosing 3 points in the winding 120° apart, and connecting them to three contact-rings.

Now, since a continuous current machine fitted with slip-rings in the manner described is capable of acting as an alternator, and since every alternator is a reversible machine, *i.e.*, capable of running as a *synchronous motor*, it is evident that our machine may, if supplied with polyphase currents through its slip rings, be made to run as a synchronous *motor*. On the other hand, a continuous current is obtainable from the commutator side of the armature, so that the machine may combine the functions of a synchronous motor and a continuous-current generator. It is thus capable of effecting the transformation or conversion from alternating to continuous-current (or *vice versa*), and if so used is known as a *rotary converter*.

The *chief use* of rotary converters is to transform three-phase to continuous current where the latter is required for a railway or a tramway system. The rotary converter has formed the subject of several important papers. A very clear *elementary* account of its chief characteristics is to be found in a recent paper by Mr. F. G. Baum, appearing in the *Electrical World and Engineer*, of New York, for April 9th, and for the benefit of our readers, we shall summarise the main points dealt with by the author. For a two-pole machine, the frequency of the alternating current is equal to the revolutions per second of the armature. As this would give an excessive speed, rotary converters are always made multi-polar, since, for a given frequency, the speed will vary inversely as as the number of poles. Further, the frequencies for which they are built do not generally exceed 30 to 40, higher frequencies involve considerable constructional difficulties. The ratio of the R.M.S. (root-mean-square) value of the alternating to the continuous P.D. is, in the case of single-phase and two-phase converters, easily obtained from the fact that the maximum value of the alternating P.D. is, in these two cases, equal to the continuous P.D. Hence the alternating P.D. is equal to $\frac{1}{\sqrt{2}}$ or ·707 times the continuous P.D. In a three-phase converter, the alternating P.D. (*i.e.* its R.M.S. value) may be shown to be $\frac{\sqrt{3}}{2\sqrt{2}}$ or ·615 times the continuous P.D.

An approximate value for the ratio of the line currents may be obtained by assuming negligible loss in the machine, and equating the power on the continuous-current side to that on the alternating-current side. This method leads to the following results:

	Ratio of alternating to continuous-current in line.
Single-phase converter	$\sqrt{2} = 1{\cdot}414$
Two-phase	$1/\sqrt{2} = {\cdot}707$
Three-phase	$\frac{2\sqrt{2}}{3} = {\cdot}943$

The *heating* of the armature coils of a rotary converter is a highly complicated problem, the heating being different for different armature coils, and the greatest rate of heat production occurring at the points of connection to the slip-rings. If we regard the maximum permissible rise of temperature as the condition which determines the upper limit to the output of the machine, then, for a machine of given size used as a continuous-current dynamo, a single-, two-, and three-phase converter, the relative outputs are as follows:

Method of using machine.	Relative output for same rise of temperature.
Continuous-current dynamo	1
Single-phase converter	·85
Two-phase ,,	1·64
Three-phase ,,	1·34

The reaction of the armature on the field varies considerably according as the converter is a single or polyphase one. In a single-phase converter there is a large fluctuation of armature reaction during each revolution, and this makes it more difficult to secure sparkless running than in a polyphase converter, in which the armature reaction is steady and feeble so long as the current is in phase with the P.D. Since there is a definite ratio between the voltages on the alternating and continuous-current sides of the machine, it follows that a rotary converter cannot be compounded in the same way as a continuous-current dynamo. By an extremely ingenious arrangement, however, compounding may be effected. The method consists in providing the usual series winding on the continuous-current side, and in interposing a reactance coil between the line and the slip-rings. If the load on the continuous-current side increases, the field of the machine is strengthened, and this causes the alternating current to *lead* with respect to the P.D. The effect of the reactance coil, when a leading current flows through it, is to produce a rise in the P.D. across the slip-rings, and thus to raise the P.D. on the continuous-current side.

Electrical Measurements.

(I) Comparison of Small Resistances.

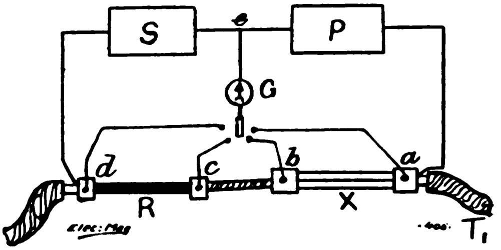


FIG. 1.

THE method of measuring very small resistances, devised by Messrs. Alfred E. Muller and Herman Wallau, does not appear to be generally known in this country, and as it yields very accurate results and may be employed to measure the low resistances of armatures, ammeter shunts, etc., it deserves attention. The arrangement of the apparatus is shown diagrammatically in Fig. 3. X is the unknown resistance which has to be determined; it should be supplied with branch potential points *ab*, and is connected by means of stout conductors in series with a standard resistance R of the Reichsanstalt pattern also possessing potential terminals *cd*. From the two free terminals, TT^1, of these resistances two 10,000 ohm resistance boxes S and P (adjusted to the same normal temperature and wound with wire of the same or negligible temperature coefficient) connected in series are connected in parallel with the resistances R and X. From the point of connection, *e*, between the two boxes S and P connection is made to one terminal of the galvanometer, G, the other terminal of which is connected successively with the potential points, *a*, *b*, *c*, *d*, by means of a key or mercury cups. Before taking readings all the plugs are removed from the box S, whilst all are in place in the box P. After connecting the terminals T and T^1 with a source capable of giving a large current, plugs are transferred from one box to the corresponding holes in the other box, thus keeping the total resistance in the two boxes constant, until no deflection is observed in the galvanometer. This operation is repeated for each of the potential points *a*, *b*, *c* and *d*. Representing the resistances in the box S, on the occasion of each of these balances, by S_a, S_b, S_c and S_d respectively, we have the following expression for the value of the unknown resistance.

$$X = \frac{S_a - S_b}{S_c - S_d} \times R.$$

This method serves also to determine the resistance of a storage cell when the terminals, T and T_1, are connected to a source of alternating currents, and when a telephone is substituted for the galvanometer. It is probable that by employing an electro-dynamometer instead of a galvanometer, whose fixed coil was connected to the main circuit before it reached the terminal T, according to a method advocated by Rowland, the resistance of an accumulator could be determined with extreme accuracy.

◆ ◆ ◆

FROM PROFESSOR to Student.

Under this heading we shall deal with the queries of Students on matters directly relating to the science and application of electricity. Letters addressed to "The Associate Editor, Students' Section," should be received before the 1st of the month, if replies are needed in the next issue. A number of replies are unavoidably held over till next month.

◆ ◆

I SHOULD be very glad if you could advise me as to the steps I ought to take with a view to taking up Electrical Engineering. I have just left the University, where I obtained high honours in mathematics and physical science. I have practically no private means: I could keep myself for a couple of years. Would it be best for me to go to a technical college or to some electrical works?

The information supplied by our correspondent is rather to meagre to admit of a perfectly definite answer to his question If he has studied experimental as well as mathematical physics, going through a laboratory course of electrical measurements, and thus already possessing a sound knowledge of the principles of electrical engineering, we should advise him to try some practical work with a firm where he is likely to gain valuable experience. It is in that case imperative for him to attend advanced evening classes and devote most of his spare time to the study of the technical details of his subject. If, however, our correspondent has only a theoretical knowledge of mathematics and physics, we should certainly advise him to become a student at a high-class technical college, such as the Central Technical College of the City and Guilds of London. Practical experience can, after all, always be gained after a student has left college; but there are very few indeed who, having started practical work at an early age, and not having had the advantage of a college training, are ever able to make up for it in later life. Students who do well during their college course, generally succeed in finding remunerative employment soon after leaving college. The best course of action for our correspondent will therefore depend on the precise nature of the training he has received at his University; it is, of course, quite possible for a man to take high honours in mathematics and mathematical physics, and yet be quite ignorant of even the most elementary laboratory processes; and there can be no doubt that a man so trained is not in a position to derive the greatest possible benefit from a course of workshop training, and is likely to lose a good deal of valuable time in the process.

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be *original* and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

Electrical Driving.

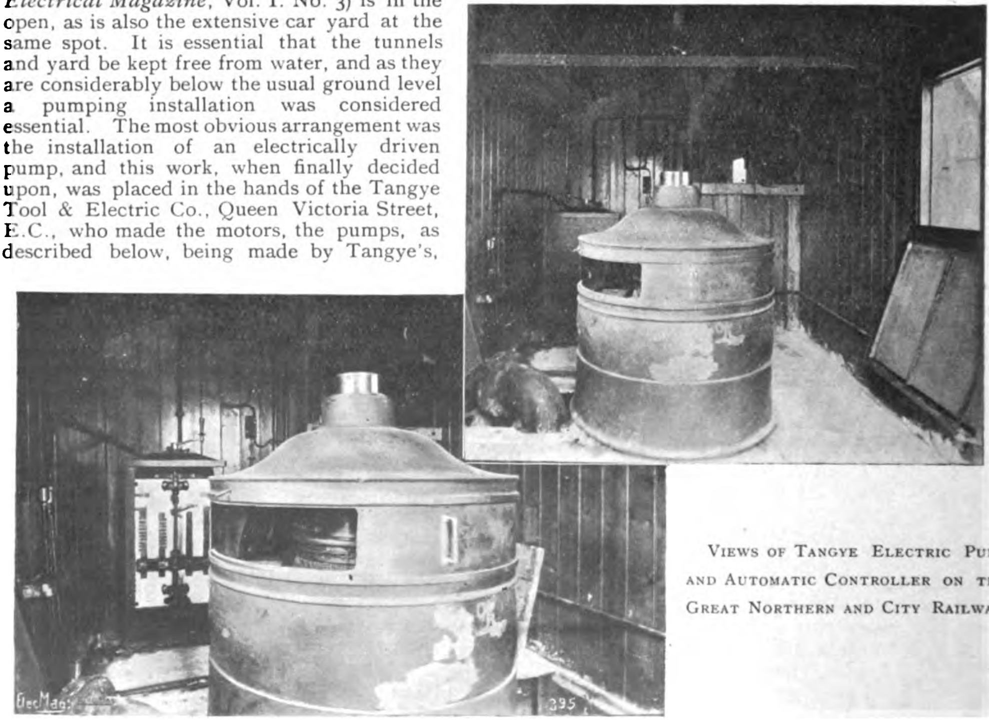
By W. NOBLE TWELVETREES,
M.I.M.E., A.M.I.E.E.

ALTHOUGH much has been said during the last year or two on the advantages of electrical driving for engineering and other industrial works, progress in this direction has been by no means so rapid as could be desired. This is due in some measure to the fact that the adaptation of electricity to the power requirements of industrial establishments is a subject that has not been sufficiently taken up by electrical engineers who are manufacturers of motors and auxiliary appliances. Consequently the advantages of the newer method of transmitting power are inadequately brought to the attention of those by whom they ought to be appreciated, and the sale of motors has not been developed so fully as it might very easily be, if a more vigorous propaganda were inaugurated by manufacturers. The problem has hitherto been studied by a comparatively limited number of specialists, who have prepared themselves for dealing with the varied needs of different industries and the unforeseen local difficulties that are sure to arise in particular cases. Many such difficulties are of mechanical rather than of electrical character, others are connected with questions of works organisation, and others again with the question of economical works management. All these points we feel sure could be dealt with satisfactorily by the average maker of electrical machinery. One of the first troubles to be met is the unwavering faith of the prospective purchaser in the efficiency of the steam engine and shafting to which he has been accustomed, and the next is disbelief in the remunerative results of a change to electrical driving. If the second of these points can be met in a satisfactory manner, the first should not give much difficulty. Therefore, the primary course of study should be the formulation of standard installation schemes representing, in a general way, various typical classes of industrial establishments to which the electrical transmission of power may be suited. Careful calculation of the working costs for different modes of electrical driving would demonstrate the most economical method for a manufactory of any given class. Further, a comparison of the working costs so obtained, with those for the mechanical transmission of power from one large steam engine or from several smaller engines scattered over different parts of the site, would be a valuable preparation to the engineer who is about to enter into the campaign for the reform of existing methods of machine driving. Of course, in every individual case, there must be special factors for consideration, and methods must be varied according to circumstances, but the fact remains that only those engineers who have thoroughly qualified themselves for dealing with the question, can be expected to gain the confidence of prospective users, and subsequently to achieve truly successful results. It is now generally recognised that electrical driving is of much value in engineering works, but those engaged in other industries are not prepared to admit so much. In the textile trades, for instance, it is believed that electrical driving is practically out of the question. This is quite a mistaken idea, for the difficulties likely to occur in textile factories are by no means insuperable, and this branch of industry presents an excellent field for exploitation by enterprising manufacturers of electric motors and machinery.

VERTICAL CENTRIFUGAL PUMPS.

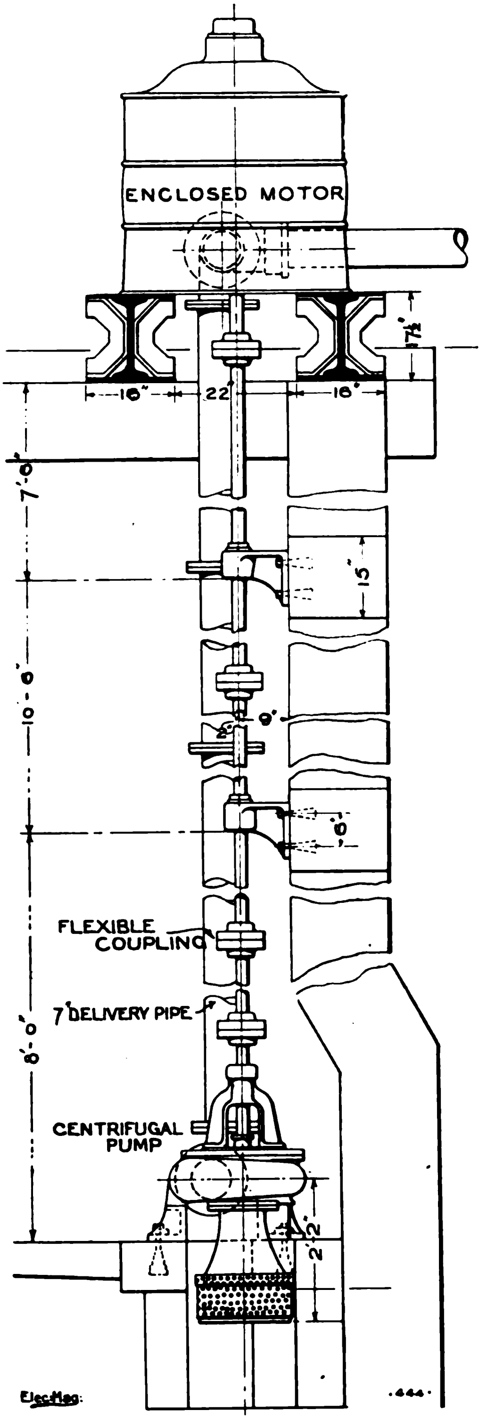
The adaptability of the electric motor is now become common knowledge in professional circles, consequently it is not considered extraordinary if a motor be arranged to drive in a position impossible in any other power unit. In our March issue we illustrated a centrifugal pump with vertical motor attached for driving some distance from the pump proper, but in this instance the distance between pump and motor was deemed advisable as hot water was the fluid dealt with. We now, however, record an interesting installation in which a similar design of motor is employed on an important railway for regular pumping work. The Drayton Park Station of the Great Northern & City Tube Railway (*The Electrical Magazine*, Vol. I. No. 3) is in the open, as is also the extensive car yard at the same spot. It is essential that the tunnels and yard be kept free from water, and as they are considerably below the usual ground level a pumping installation was considered essential. The most obvious arrangement was the installation of an electrically driven pump, and this work, when finally decided upon, was placed in the hands of the Tangye Tool & Electric Co., Queen Victoria Street, E.C., who made the motors, the pumps, as described below, being made by Tangye's, Limited. The illustrations depict the motor in position with its automatic starting switch, and also they give a sectional elevation through the complete plant.

The duty of the Drayton Park pump is to lift 50,000 gallons of water per hour from a sump to a total head of about 44 ft. through 20 ft. of horizontal piping in addition to the vertical. It is of the centrifugal type, fixed at bottom of sump, having suction and delivery branches 7 in. diameter, and is arranged to work vertically. It is driven direct by a 4 pole motor, pump and motor being connected up by about 25 ft. of vertical shafting. The vertical spindle motor to drive the pump is made enclosed, fixed on girders at the top of the sump. It is capable of giving 28 h.p. at 800 r.p.m. when supplied with continuous current on 500 to 550 volts circuit. The armature is supported on a ball bearing, which also takes the weight of shaft. A bearing is provided at the commutator end to steady the shaft, and oil throwers of large diameter prevent oil reaching the commutator. An automatic motor starting switch is provided, insulated with mica and porcelain and mounted on a marble base—the whole being contained in an iron case. This starter can be operated automatically by means of a float and counterbalance through a water tight reversing switch-lever working through a gland, or it can be operated by hand if desired. There is also a smaller plant of the same design working at Gillespie Road. This pump is for draining the tunnel, and delivers 3,000 gallons of water per hour to a total vertical height of 60 ft. through 300 ft. of horizontal piping. It comprises one 2 in. vertical spindle centrifugal pump fitted

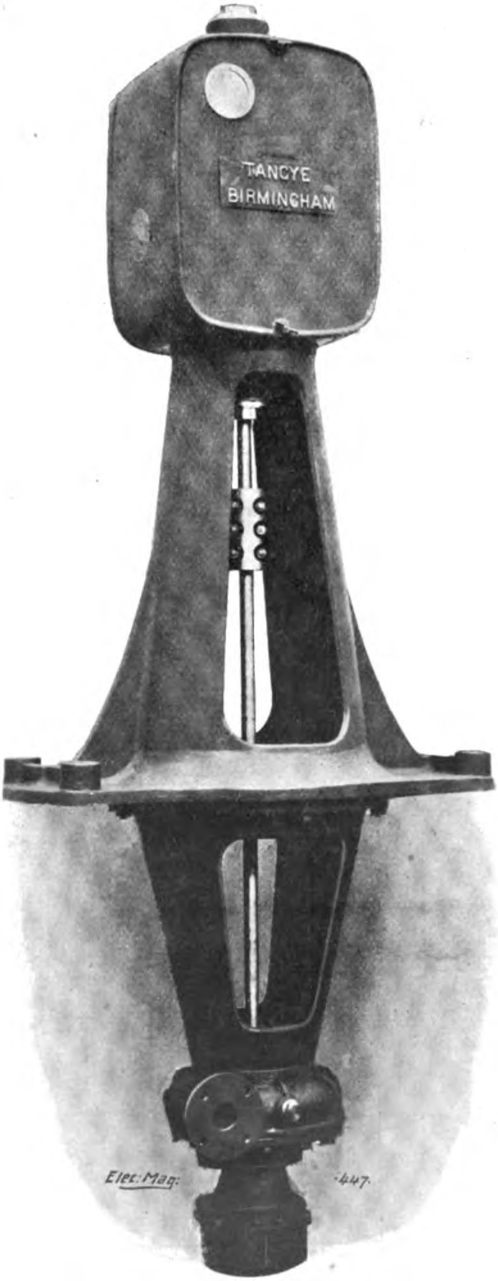


Views of Tangye Electric Pump and Automatic Controller on the Great Northern and City Railway.

with steel spindle about 4 ft. long, coupled up to a two pole enclosed type motor running at about 1,500 r.p.m. on a circuit of 500 volts continuous current. This plant is fitted with electrically actuated automatic starter for working by means of a float. There is also a similar plant to that at Gillespie Road, for draining the tunnels at Poole Street and Moorgate Street, but the automatic



Section through Vertical Electric Pump.



Another Form of Tangye's Electric Centrifugal.

starting and stopping arrangement is not fitted to this.

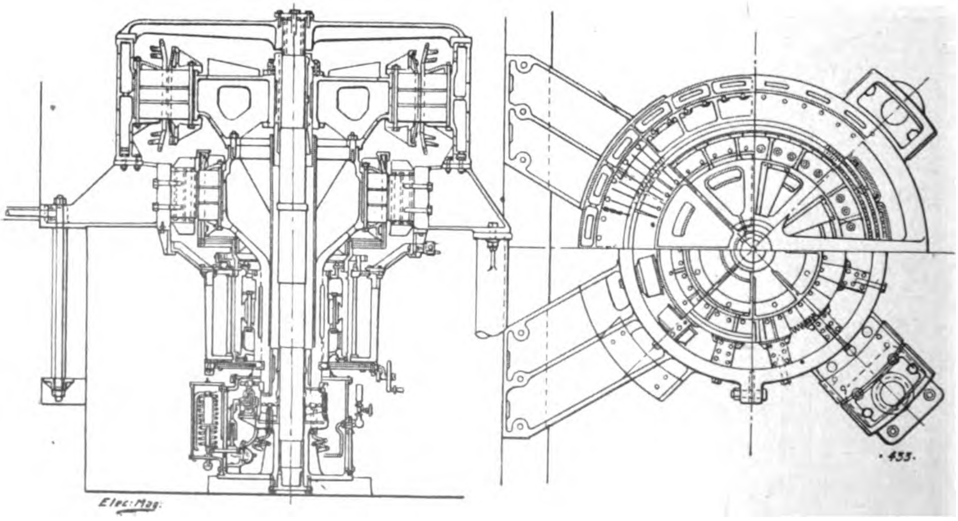
We illustrate in addition a compact design of centrifugal, with vertical motor, manufactured by the same firm.

VERTICAL MOTOR-GENERATOR SET.

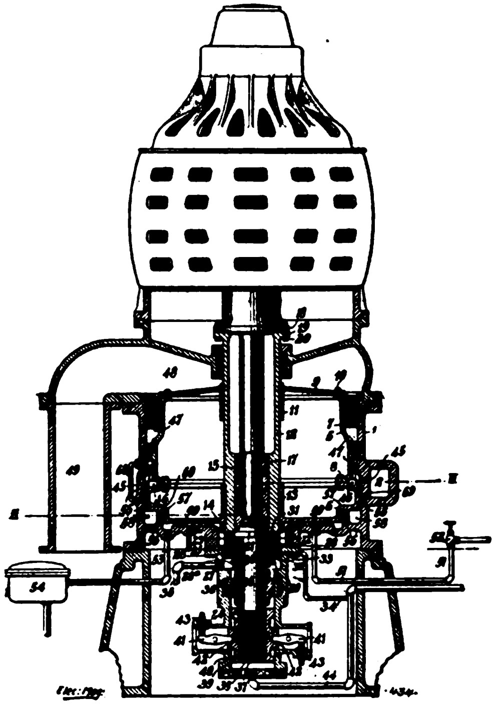
THE Oerlikon Company have recently equipped the Lend-Gastein branch of the Neuhausen Aluminium Industrie Gesellshaft with electrical apparatus. An important feature in the installation is the use of six vertical motor-generator sets of which details are given on the drawing here reproduced. The motors of each set are of the synchronous type, each built to give an output of 1,000 h.p. at 10,000 volts, 45 cycles, 340 r.p.m. The 160 volt direct-current generators are each of 560 kw. capacity. The generator field is of cast iron. The motor armature is placed directly above the field of the generator, and is enclosed by a single-piece cast-iron frame. The rotors of both machines are attached to each other, and revolve around the stationary shaft, their total weight being 27,500 lbs. This weight is taken up by a spur foundation placed beneath the commutator of the generator. The stationary cast-steel spur plate is frustum-shaped and rests in a cast-iron pan. The shell of the lower foundation, which is built into the commutator, has a flange at its bottom, resting on the spur plate. The generators have twelve poles each, and are shunt wound. The armature has an outside diameter of 4·9 ft., and a core diameter of 1·3 ft., the core being cooled by two ventilating slits. The armature contains 204 open slots for the windings, each slot containing four insulated copper wires. The connection between the armature winding and the commutator is made according to a new system devised by the Oerlikon Company, comprising copper forks, each of which combines two commutator laminations. The commutator consists of 408 segments of hard-drawn copper, 24 in. long, and with an outside diameter of 36 in. All insulating rings in the interior of the commutator are of mica. The twelve poles which carry the shunt windings are built of soft sheet iron, and are screwed to the field frame. The brush holder has twelve brushes, each with 11 carbon tips, and the holder can be raised simultaneously when necessary to clean or true the commutator. The motor has sixteen poles. The high-tension winding (hand-wound) is laid in 192 slots, each containing eighteen wires insulated from each other by mica sheets 0.1 in. thick. The rotor of the motor has a short-circuited winding laid in 320 semi-open slots, each slot containing two spool halves. Each spool forms a closed winding, and consists of three parallel copper strips 8 × 2·5 mm. cross-section.

WESTINGHOUSE VERTICAL STEAM TURBINE.

WE illustrate on this page, a new vertical turbo-generator recently patented by Mr. George Westinghouse, of Pittsburg, and assigned to the Westinghouse Machine Company. Full details of construction are given below the vertical section. To avoid all tendency to unbalancing the rotary member of the turbine by the impact of the steam upon the valves, steam is introduced through three groups of nozzles 120° apart. The upper end of the cylinder is extended to form a horizontal flange, the upper face of which normally makes a close fit with the lower face of the wearing plate. After steam has passed the last set of steam-using devices it exhausts into an annular chamber communicating with the condenser, so that when the turbine is operating as a condensing engine a considerable degree of vacuum will be maintained in the upper end of the casing above the rotary parts. By reason of this vacuum, atmospheric pressure in the space between the lower end of the drum and the lower end of the casing will serve, either partially or wholly, to



VERTICAL MOTOR GENERATOR.



WESTINGHOUSE VERTICAL TURBINE.

support the drum according to the degree of vacuum and the area of that portion of the drum which is subjected to atmospheric pressure. Air may be introduced to the space mentioned through any small inlet provided with a suitable valve. This type of turbo-generator takes up very little floor space, and we shall be interested later to hear of some records as to its performance in practice.

(1) *Casing.*
(2) *Steam chest.*
(5) *Drum.*
(6) *Lower part of drum.*
(7) *Middle part of drum.*
(12) *Sleeve.*
(14) *Ring holding lower part of turbine in position.*
(16) *Shaft.*
(17) *Dynamo shaft.*
(23) *Wearing plate.*
(24) *Bearing housing.*
(25) *Ring.*
(26) *Cylinder.*
(28) *Flange.*
(28a) *Worm wheel.*
(29) *Worm pinion.*
(30) *Passage communicating with the cylinder and oil distributing grooves.*
(32) *Annular passage.*
(33) *Horizontal passage.*
(34) *Pipe through which oil is supplied to horizontal passage.*
(35) *Pipe through which waste oil is discharged.*
(39) *Rings on a longitudinally adjustable cylindrical head.*
(41) *Levers.*
(42) *Sockets.*
(38) *Annular flanges.*
(46) *Annular chamber.*
(47) *Steam-using devices.*
(48) *Chamber into which steam exhausts.*
(50) *Space.*
(51) *Pipe.*
(52) *Valve.*
(53) *Drain pipe.*
(55) *Packing rings.*
(56) *Annular flange.*
(57) *Another set of packing rings.*
(58) *Space between two sets of packing rings.*
(69) *Annular space above the packing rings.*

SPEED-TORQUE CHARACTERISTICS OF THE SINGLE-PHASE REPULSION MOTOR.

THE single-phase commutator motor has been much discussed of late, and at present it appears such a motor is the only type that will start under a heavy load with a reasonable consumption of energy. During a series of experiments, with various types of alternating-current commutator motors, considerable attention was given by Mr. W. I. Slichter, to the repulsion motor, and he has recently placed before the American Institute of Electrical Engineers, some of the results so obtained. The accompanying diagram is taken from Mr. Slichter's paper. The characteristics of a repulsion motor were shown with revolutions per minute as a basis. The tests were made on a 60 h.p. 25 cycle 500 volt motor, and shewed the rapidly rising efficiency and power-factor and the large torque at starting. The starting torque is 2,300 ft. lbs., with an input of 325 ampères, and the normal torque during acceleration, 450 ft. lbs. at 750 revolutions and 125 ampères. The starting torque is thus five times normal, and the starting current 2·6 times normal; or the torque per ampère at starting is 1·92 times what it is at normal speed, should occasion demand the full starting capacity of the motor. The steep speed-characteristics of the motor are also shown in Fig. 1, the full lines referring to a later type of repulsion motor and the broken lines to a standard direct-current series railway motor. The curves were plotted in the usual way, with current as a basis. It may be seen that the torque increases more rapidly with increasing current in the repulsion motor than in the series, and, conversely, that the speed of the repulsion motor increases more rapidly with decreasing current than in the series motor. Efficiency, including gear-loss, is given, and is 84·5 per cent. at the maximum for the alternating-current motor. This motor was designed with the steep speed-characteristics for acceleration work, for which it is shown to be admirably adapted.

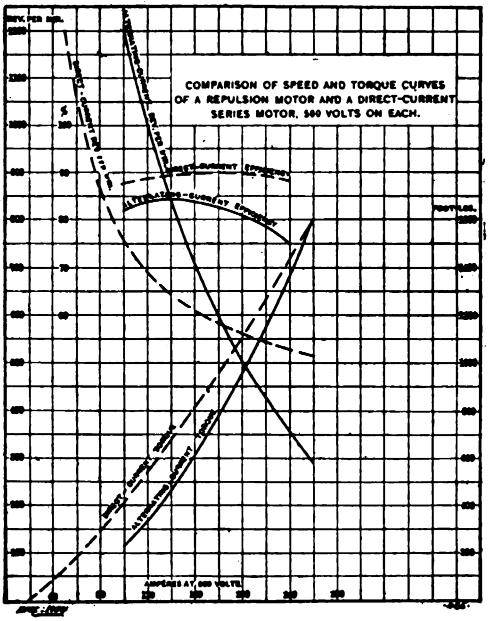
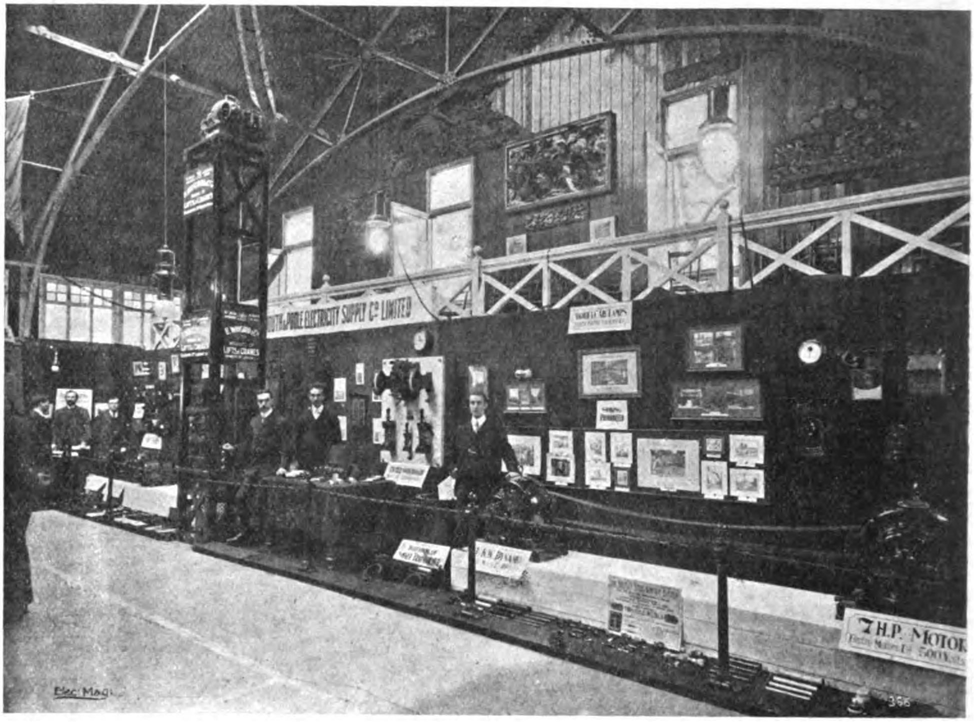


FIG. 1. SPEED CURVES OF REPULSION MOTOR.



BOURNEMOUTH ELECTRICAL EXHIBITION.

(The Bournemouth and Poole Electricity Supply Co.'s Stand).

[Pressure on our space prevented the inclusion of the above in our last issue, when we described this interesting exhibition. The comprehensive nature of the company's exhibit can be readily gathered from this illustration.]

A NEW PORTABLE POWER-FACTOR METER.

THE accompanying illustration shows an instrument designed by the Westinghouse Electric Manufacturing Co., of Pittsburg, Pa., to determine the power-factor of a polyphase circuit. This instrument indicates the power-factor upon a scale, recording on the dial by the position of a pointer the angle of phase difference, and giving the actual power in percentage of the apparent power. It operates with equal accuracy on either a leading or lagging current, and indicates whether the current leads or lags, whether power is delivered to or by the circuit, and the power-factor. It consists of two sets of coils, one containing a separate series winding for each of the phases in the circuit, and the other a potential winding connected across one phase of the circuit. The series coils are arranged to produce a resultant rotating field. A small iron vane, passing through the potential winding, forms movable pole-pieces for this winding, which takes up a position in the rotating field, depending upon the phase relation of the currents producing this field and the voltage impressed upon the potential winding. The angle between the current and the voltage is indicated on a scale by the pointer attached to the shaft carrying the movable vane, the scale being so graduated as to read directly in power-factor. If the power-factors of the different phases differ from each other the average power-factor is indicated. Suitable instruments are made for two and three phase circuits.

◆

DEVICE FOR CENTRING SHAFTING.

A HANDY device has lately been invented by Mr. F. H. Hudson, of Boston, U.S.A., for centring shafting, round and hexagon bars, etc. This machine is light and portable, consisting of a universal chuck fitted to a frame of aluminium compound, in which the shaft is inserted, and which holds in its opposite end a motor with a drill and countersink aligned with the centre of the chuck. The motor travels in a gib slide and is operated by a feed screw and handle, causing the drill and countersink to enter the end of the shaft or bar. Wear and play are taken up by slides and set screws at the base of the casting. A stop across the inside of the chuck opening, prevents the drill point from being brought into too sudden contact with the end of the bar, even if carelessly handled. This machine does away with the necessity of carrying a heavy bar to a centring machine, or of centring it in a lathe, as the device can be carried to the bar wherever the latter may be. Motive power is obtained from any electric light fixture of 110 volts direct current, or the appliance can be operated by a small storage battery. Power is controlled by a switch on the rear of the motor.

COAL CONVEYORS FOR ELECTRICITY WORKS.

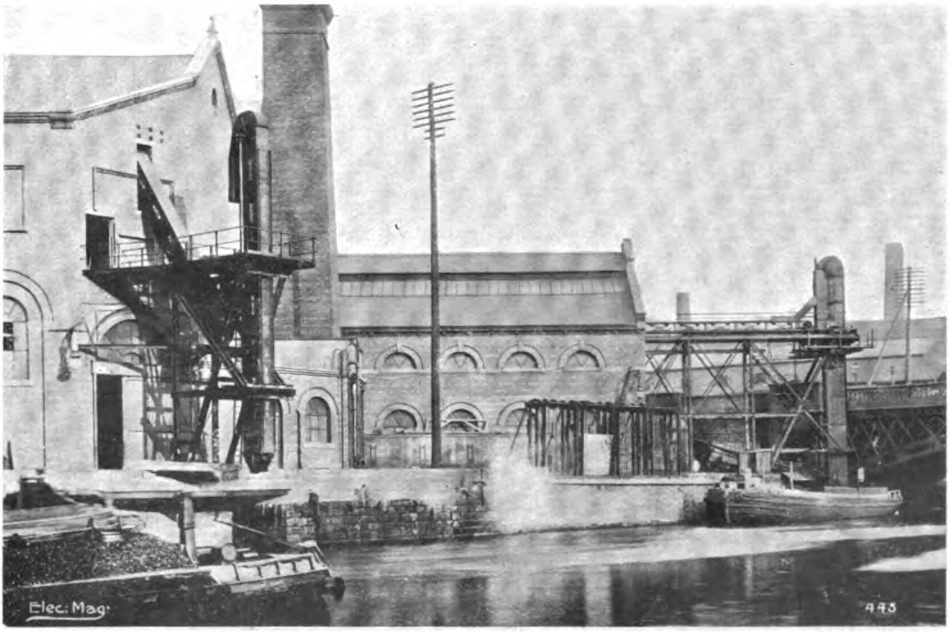
THE increasing size of power plants gives added importance to the transport of coal to the boiler-house and the removal of ashes therefrom. All large stations now have recourse to some mechanical appliance for this work, and as a result, the manufacture of coal handling apparatus has become a speciality. The work of Messrs. Graham, Morton & Co., Leeds, in this direction, is worthy of our notice as typical of what is now done in coal conveying, and of the rapid advances made in this branch of engineering. As a remarkable instance of the latter, we cannot do better than point to the magnificent new works recently erected by the company to cope with its increasing roll of orders. In this respect, we must remind our readers that these works were built in the record time of 5½ months, an engineering feat commendably spoken of by H.R.H. the Prince of Wales, who signified his approval in a recent communication to the firm. This in itself speaks more than volumes for the development of coal conveying apparatus and for the enterprise of a British firm in their commercial exploitation. Many important installations of their apparatus have been laid down by Messrs. Graham Morton, among these being some of the larger electricity works in this country. The equipment usually installed is adequate for the dual purposes of unloading and conveying the coal, and removing the ashes. Elevators, grabs, cranes, chain belt and bucket conveyors are all pressed into service as occasion arises, and each performs its function with equal satisfaction. At Pigeon House Fort, Dublin, in the Corporations new power house a very complete plant has been laid down. The work comprised the erection of a steam crane and grab for 30 tons of coal per hour, the grab discharging 15 cwt. at each operation into the boiler house hoppers. The entire coal and ash handling plant was also included, and in addition, an extensive coal store built of steel and concrete. The conveyors and elevators for both coal and ashes are electrically driven.

The Leeds Corporation Tramway Station, is also fitted with the company's plant, there being a complete installation for coal and ash handling. In the former are included two vertical elevators (see illustration) for unloading barges at the river side, arranged to be raised or lowered according to the height required. These elevators deliver into conveyors carrying the coal to the coal store above the boilers. Other equipments have been installed in electricity works at Battersea, Bootle, Bradford, Blackburn, Oldham, Harrismith (S.A.), Bloemfontein.

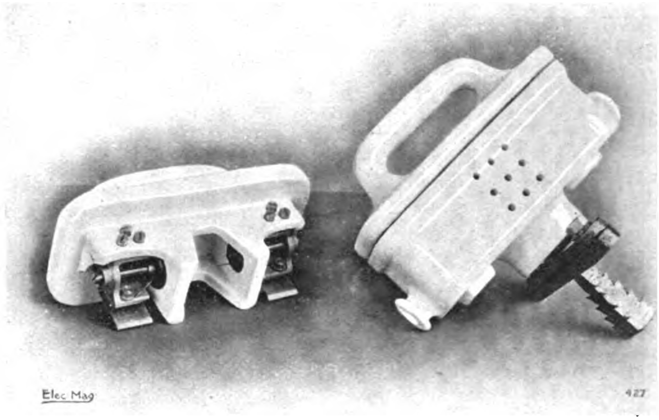
The same firm contract for the supply and erection of steel buildings, and in this direction an order has recently been secured for the electricity station to be erected at Harrismith. The enterprising manner in which Messrs. Graham, Morton have developed their business, and pushed it in face of keen competition, is worthy the emulation of all British firms.

THE SPARKLET H.T. FUSE.

THE principle of the sparklet fuse is now so well known that, in referring to the most recent form of this device, we need only briefly revert to its chief features. The development of fuses of small compass for high voltage work is the outcome of much trouble with long breaks, entailing cumbrous appliances, which occupied valuable space. Oil



GRAHAM, MORTON & CO.'S COAL ELEVATORS, LEEDS CORPORATION TRAMWAYS STATION.



H.T. Sparklet Fuse—Wall Pattern.

fuses have been developed to a degree of compactness unattainable with the air variety, and have become common enough; but the Partridge fuse seems to defy competition, while it assumes many useful forms. Our illustration depicts the wall pattern, with fuse holder and terminal body, into which is secured a wall bolt for fixing purposes. The insulating material is of highly glazed porcelain, into which the H.T. fittings are fixed and carefully protected from accidental contact. The fuse holder, as will be seen by the illustration, is shaped to form a fusing chamber containing the fuse itself. The ends of the sparklets project into this chamber, and, on the formation of the arc, at once liberates carbon dioxide, which immediately quenches the arc, the fuses and gas escaping through the holes in the terminal body. Two sparklets are provided, to guard against the possibility of failure, though no such mishap is on record in experiments extending over 18 months. The ends of the fuse are clamped to contact blocks fitted with clips, which engage with contact springs in the body of the fuse. An extremely neat device is thus formed, and one which, while remarkably effective, is yet compact and safe. The fuse is also made in modified forms for houses, switchboards, and underground work. Its manufacture, in all forms, is undertaken by Messrs. Elliott Brothers, Century Works, Lewisham, S.E., and we need hardly remind our readers that it is the patent of Mr. Partridge, chief engineer of the London Electric Supply Corporation.

Industrial Electric Cable Construction in Germany.

In the concentric cables of the Societé Sud-Allemande de Mannheim, whose work may be considered typical of German cable manufacture, the copper core consists of a cylindrical strand of 19 or 37 wires insulated by paper strips. The strips are wound to form a double spiral, the interstices left by the first strip being filled by the second. Then two strips are similarly wound, but in the opposite direction, the process being repeated until the desired thickness is obtained. The cable is then wound with jute or covered with a cloth band. The whole is next immersed in the insulating material at fairly high temperature, and left therein until every particle of moisture is evaporated from the paper, and the cable is thoroughly impregnated. After this a seamless lead sheath is added by the Berthould-Borel process, by which cables of any length may be covered. Outside the lead a given number of paper-insulated copper wires are spirally wrapped forming the exterior conductor. This conductor is in turn protected by leaden sheathings bound round with bituminised jute. Round the whole are wound two layers of strip iron, and a final covering of bitumenised jute, or a cloth band, is applied. The internal lead sheath is provided to give a plastic surface between the "outer" and "inner." So far as the external armouring is concerned the Mannheim works use iron strip for underground cables, galvanised wire or segemental iron sheathing for mine cables, a combination of two of the three above mentioned forms of armouring, for cables used under water. The lead covering for the latter consists of two sheathings separated by a thin layer of insulating composition. In high tension cables the internal lead sheathing is omitted. For low tension cables the German Union of Electrical Engineers have standardised the materials to be employed, their thickness, order of application, and the tests the completed cables have to withstand according to the pressures and the purposes for which they are constructed. These standards are now generally adopted by German cable makers.

A Diamond - Bearing Meter Screw.

One difficulty with which central station operators have to contend is the tampering with meters by their customers; and another is the wearing out of the jewel bearing which carries the pivot of the rotating member of the meter. To provide suitably for these difficulties, Messrs. John Wennstrom's Sons Co., of Brooklyn, N.Y., are now making meter pivot bearings of diamonds instead of the commonly used sapphire. The screws are made of certain lengths and with certain threads, according to the meter with which they are to be used. The brass screw proper is made in the ordinary way, and seated within the hollow of this is a finely tempered spring. Resting upon the spring is a brass stud: in this stud is inserted a steel collar carrying the diamond bearing, and immediately above the bearing is placed a sapphire bushing. In order to prevent the puncturing of the bearing, a rough diamond is set into the steel collar, having a thickness twice as great as that of the ordinary jewel. This is then faced off flush with the top of the steel collar, and the sapphire bushing is placed on top. The manufacturers claim that the life of this bearing is some 18,000,000 revolutions, and state that wherever it has been used it has given the greatest satisfaction.

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

* * *

Fuses v. Circuit Breakers

For the Protection of High Potential Circuits.

By W. S. TOPLIS.

The vital elements of every system are its switching and protective devices, therefore it is essential that engineers should take every precaution and care in selecting these devices.

On making a comparison between the practice of the British and Continental power and lighting companies, one is at once struck by the scarcity of automatic high potential circuit breakers in use by the British companies. Fortunately this state of things has been realised, and some of the later companies are fully equipped with these devices. Considering the prime function of a power company, *viz.*, the maintaining of a continuous and unfailing supply, this diversity of opinion regarding protective devices gives a basis for discussing the merits of fuses and circuit breakers as a means of protecting high potential circuits.

The subject may be divided into three sections—

Protection of Generator circuits.
„ Line circuits, transmission end.
„ Line circuits, receiving end.

We will take each section in turn, and assume that it is equipped in the first instance with fuses, and we will then assume the substituting of automatic circuit breakers for the fuses.

GENERATOR CIRCUITS.

Assume several generators are running in multiple, and each generator is equipped with fuses. A generator suddenly develops a short in its armature winding, or looses its field, with the result that it ceases to be a generator and becomes a receiver of power. This power is, of course, supplied by the remaining generators, which now have to supply the faulty generator for such time as its protective device takes to operate, which in this case is a fuse, and consequently will not operate until the current which is passing has reached the amount for which this particular fuse was arranged to "blow," say, two or three times full load of the faulty generator. In nearly every case it will be found that the generators, in attempting to meet this demand and also the power for the lines, will "blow" their own fuses. This, of course, means a complete interruption of power which will take some little time to restore, owing to all the converting appara-

WESTINGHOUSE POLYPHASE TIME LIMIT RELAYS.
(See page 536.)

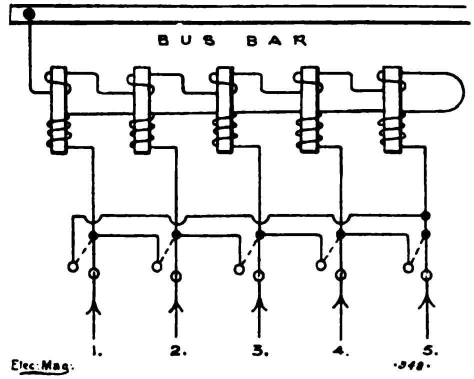


Fig. 1. Diagram of Choke Coils.

tus, &c., having to be started up again in the sub-stations. It is therefore needless to say that occurrences similar to that depicted above would be most detrimental to the reputation of a power company.

Let us now substitute automatic circuit breakers which are designed to open the circuit when the direction of the current is reversed. One of the generators again "breaks down" and the rest immediately "pump" into it, but as soon as this current which is now travelling in the reverse direction has reached a predetermined amount for which the circuit breaker was set, say 15 per cent. to 20 per cent. of full load current of the faulty generator, the circuit breaker will operate, and thus cut off the generator from the bus bars, and at the same time cause the remaining generators to take up the load originally alotted to the faulty generator. This state of things is certainly to be preferred to that depicted under fuse control. No doubt some engineers will point out that a disturbance such as a short circuited armature would in any case have thrown out any synchronous machinery on the line, and thus the same trouble would arise under circuit breaker control. This point, however, raises a question not treated in this article, *viz.:* the choice of frequency and sub-station apparatus.

Line Circuits (Transmission End).

Here, if one wishes to dispense with an adjustable time element, fuses may be used. These latter, though they compare favourably with automatic circuit breakers from a circuit breaking point of view, do not offer the facility for a quick restoration of power to the circuit which is advanced as one of the chief claims for the automatic breaker.

Regarding the time element question, it must not be assumed that the blowing of a fuse is devoid of a time element. The time between the short circuit and the melting of the fuse varies according to the material from which the fuse is made, its surroundings, also the method of clamping or connecting it in circuit. Although these points have been carefully pre-arranged to give a certain time element, this time is, for obvious reasons, by no means constant and therefore of little use.

The time limit relays used in conjunction with automatic circuit breakers are usually adjustable from one to eight seconds; thus, by means of these relays, the circuit breakers will discriminate between a partial or momentary short circuit and a complete short circuit.

Line Circuits (Receiving End).

The receiving end of a line feeder is practically the same as the generator circuit; therefore the foregoing remarks, under generator circuits, apply equally well to this case. Al-

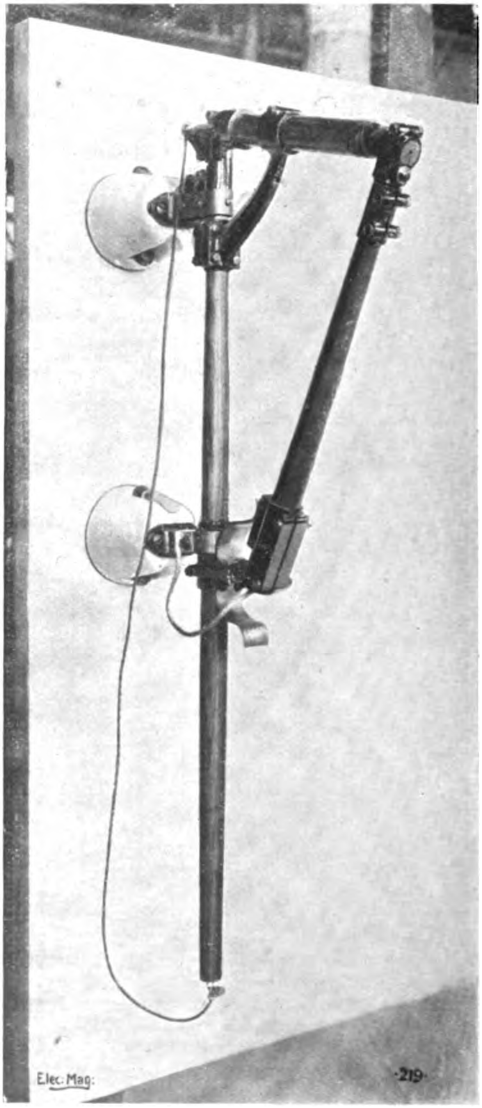


Fig. 2. Switch Fuse.

though it is usual to employ either fuses or circuit breakers for protecting circuits, it is not absolutely necessary, for by adopting a system of choke coils devised by Mr. L. Andrews it is possible to dispense with them.

The diagram in Fig. 1 which is self-explanatory, gives an idea of the utility of this system.

No. 5 feeder short circuits; the rush of current to the fault from the four other feeders is impeded by the choke coils, and the system continues to operate at about 80 per cent. normal voltage. To restore full pressure in case the fault persists, choke coils 4 and 5 are put in multiple by the switch in No. 5, and No. 5 feeder switched out at the power house. Regarding the choke coils, the essential feature of the design is the unbalancing of the ampère turns at the time of the fault. For instance, under normal conditions and all feeders equally loaded, the flux in the core of each choke coil is neutralised, but in the event of a fault, the ampère turns are unequal, and in consequence the resultant flux re-acts on the windings, tending to again produce a balance. Under normal conditions, it will be noticed that the entire loss in these coils is purely ohmic.

The automatic high potential circuit breaker is now usually specified by the engineers of power companies, and therefore it will necessitate contractors paying greater attention to these devices.

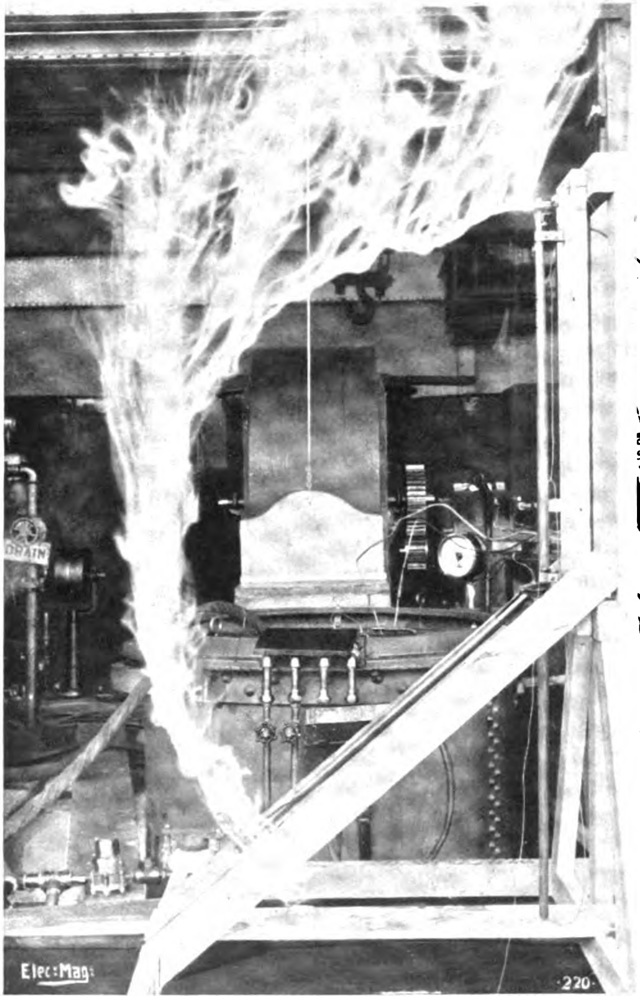


FIG. 3. SWITCH FUSE IN ACTION.

The British Westinghouse Company have made a special study of these requirements, and have brought circuit breaking devices to their present state of efficiency.

The following is a brief description of several of their standard productions.

Fig. 2 illustrates a switch fuse, used for breaking circuits up to 40,000 volts. As shown in the illustration the circuit breaker consists of two hard wood poles, one being longer than the other, mounted upon a marble base. The wooden poles are connected by a hinge, so that their extremities are in line at the upper end. On the upper end of each pole is mounted a copper sleeve supporting a round carbon contact block with a hole through its centre. The longer pole is provided with spring jaws and clips, so that it may be quickly and easily attached to or detached from the terminals on the marble base. The short pole has a flexible wire running through its interior; this wire is connected to the copper sleeve at the upper end of the short pole, and to the lower clip terminal on the long pole. The sleeve at the upper end of the long pole is connected to the

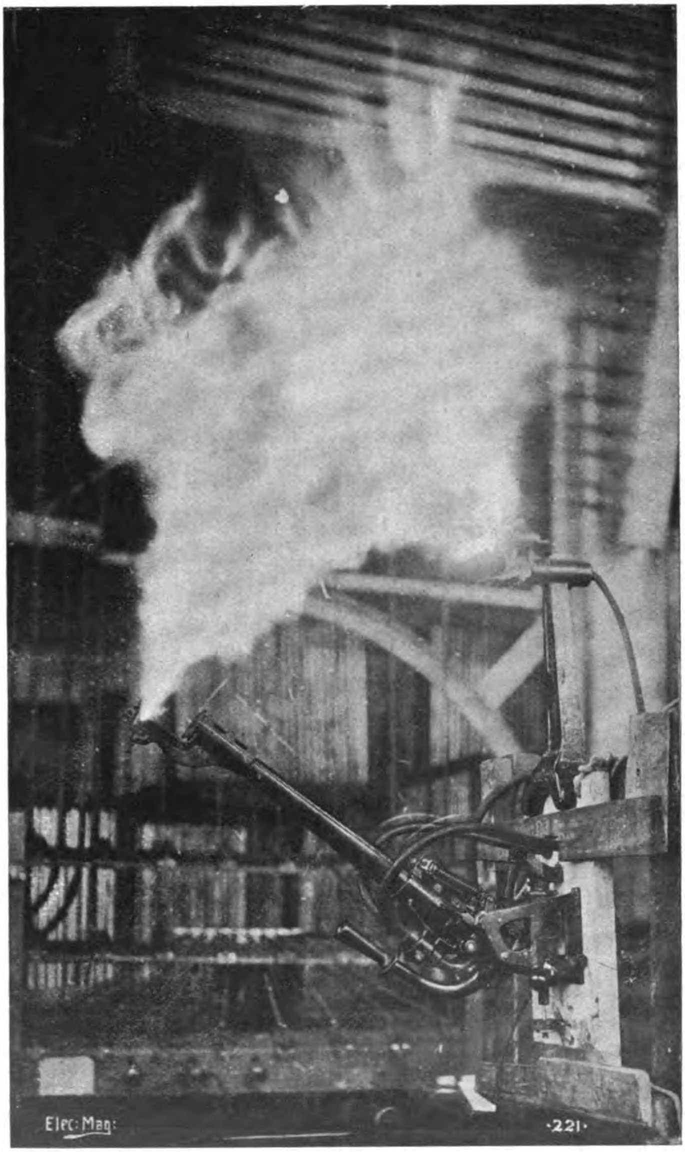


Fig. 4. Automatic Air Circuit Breaker in Action.

upper clip terminal. Between the carbon contacts is an expulsion tube through which the fuse wire passes. When the fuse blows, the break is made in the small hole in this tube, which greatly limits the expansion of the arc. A strong draught is caused, which helps to subdue the arc. The poles, having had fuses inserted, are placed in position by taking hold of the lower end of the long pole. When the fuse blows, the hinged pole is released, and by the action of the spring at its lower end, falls away from the stationary pole, thus making a very long break. The long cord shown in illustration is attached to a lock cam which releases the fuse wire when this cord is pulled, thus converting the device into a switch.

Fig. 3 illustrates this type of fuse in action. Note the expulsion tube or "sneezer" was not fitted in this case. Fig. 4 illustrates an automatic circuit breaker embodying the principle of the foregoing fuse circuit breaker. The release of the hinged rod can be effected either by a solenoid in the main circuit or a trip coil operated by relays. A noticeable feature in the design of this circuit breaker is the great pains taken to prevent "bugging" of the contacts. The current carrying contacts are protected by copper tips, so that, when the circuit is opened, the current is gradually shunted from the copper contacts to the carbon contacts by steps of such low resistance that no arcing can occur until the final break is made on the carbons. These circuit breakers are built for potentials from 2,200 to 33,000 volts. For circuit breaking on systems where, for obvious reasons, it is not advisable to use "flare" breakers, the oil circuit breaker should be used.

Figs. 5, 6 illustrate a standard type designed for use up to 33,000 volts. This breaker is three pole, double break per pole and operated by an auxiliary D.C. current, taken from the exciting circuits. The switch itself is erected on masonry, with each pole and oil tank in a separate fireproof chamber. There are two stationary contacts per pole, one connected to the incoming lead and the other to the outgoing lead of the same phase, each contact is carried in a porcelain insulator which is in turn carried by a cast iron frame. The cast iron framing which supports the oil tanks is held by strain insulators to the underside of a stone slab placed on top of the masonry structure.

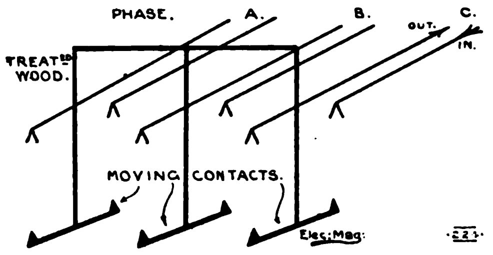
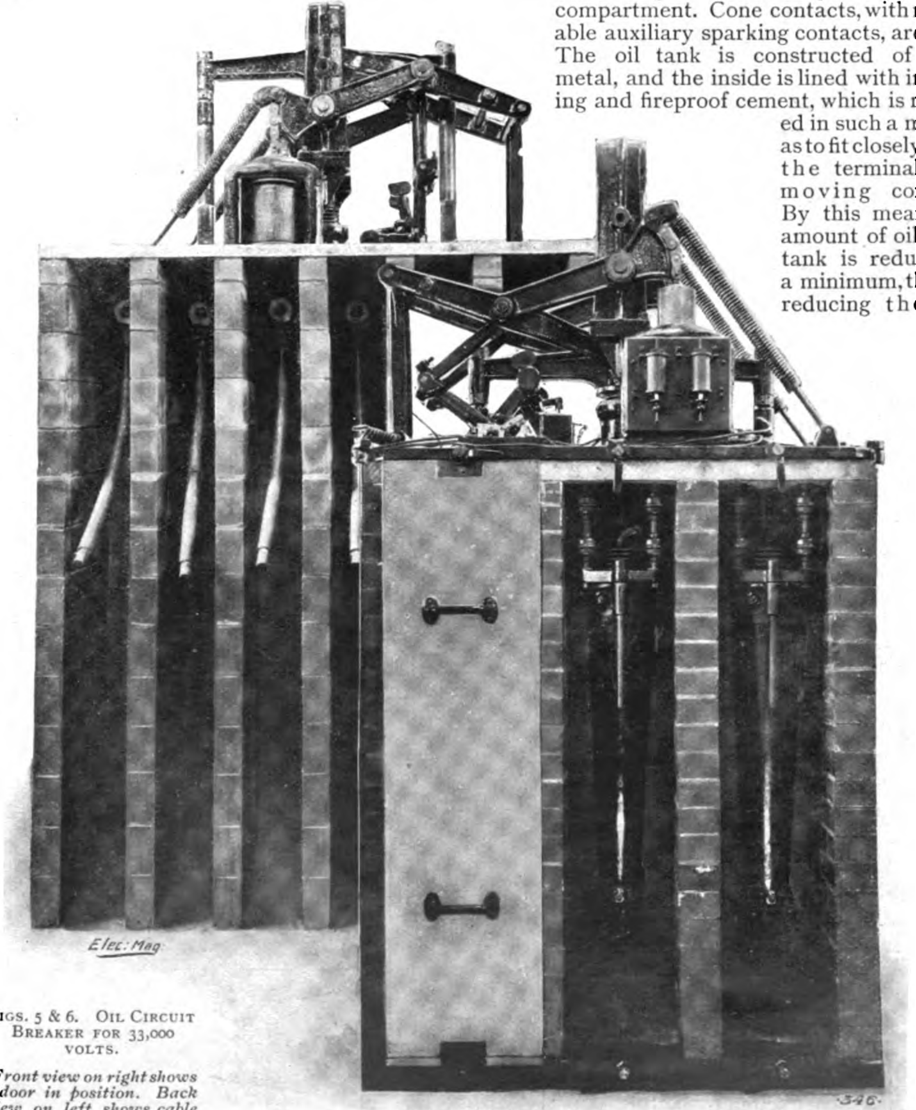


FIG. 7.
DIAGRAM OF CONTACTS, 33,000 VOLT OIL BREAKER.

The movable contact, shown in Fig. 7, is fastened to the end of a treated wooden rod; the three wooden rods are connected to a common cross-bar, which is raised through a system of levers by the two closing magnets, assisted at the beginning of its motion by the balancing springs. The switch is held closed by a pair of toggles. Upon opening, a trip magnet strikes a blow on the toggles, causing the same to break centre. Gravity, then, assisted by a strong spring in the top of the main column, causes the cross-bar with contacts to fall into the off position.

For each pole there are two breaks in series, and each pole is in a separate fireproof compartment. Cone contacts, with renewable auxiliary sparking contacts, are used. The oil tank is constructed of sheet metal, and the inside is lined with insulating and fireproof cement, which is moulded in such a manner as to fit closely about the terminals and moving contacts. By this means the amount of oil in the tank is reduced to a minimum, thereby reducing the fire



FIGS. 5 & 6. OIL CIRCUIT BREAKER FOR 33,000 VOLTS.

(Front view on right shows a door in position. Back view on left shows cable chambers.

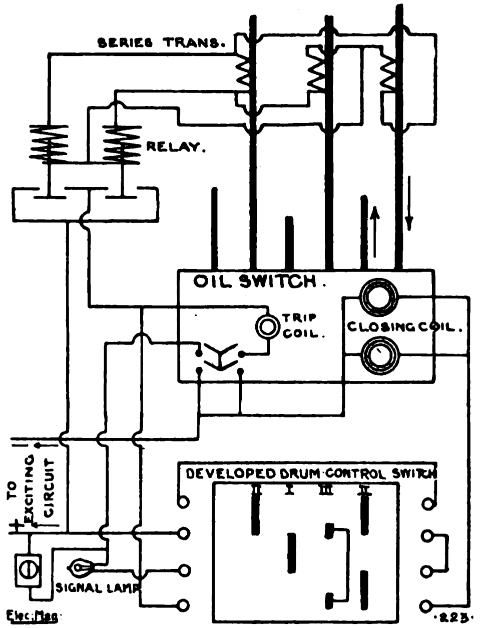


Fig. 8.
Connection Diagram, 33.000 volt Oil Breaker.

risk. Mounted on the top slab is a small double pole, double throw knife switch. This switch is operated by the toggle levers, and is used in conjunction with the signals and tripping circuits. The controlling and indicating devices for this type of C.B. are mounted on the control desk, usually placed on a gallery having full view of the power house.

Fig. 8 is a wiring diagram for this circuit breaker, showing connection for the electro-mechanism tell-tale, signal lamp, and the controlling switch. This controlling switch is of the drum type, with three "notches": *viz.*, "closed," "off," and "open." The drum of the switch is controlled by a spring, which permits the following movements: If handle is turned to the "closed" position, it will spring back to the "off" position immediately the hand is removed from the handle; when the handle is turned to the "open" position, it will remain there when the hand is removed; when the switch is in the "off" position, it connects the control circuit in such a manner that, should the circuit breaker be tripped automatically, a lamp lights up on the control desk, thus notifying the attendant. If the switch is opened by the attendant, this lamp does not light up.

Large power switches, similar to the one just described, are universally controlled by relays operated by series transformers placed in the main circuit. A typical reverse current relay for polyphase circuits is illustrated in Fig. 9. The relay operates on the principle of the induction integrating wattmeter, and, in consequence, retains the sensitiveness of that instrument. Adjustable contacts for the tripping circuit are arranged to vary the amount of reverse current at which the relay is desired to operate.

Fig. 10 illustrates a polyphase overload relay, with time limit attachment (see page 531). The essential feature of this relay is a dashpot fitted with adjustable contacts for the tripping circuit. This dashpot is controlled by a solenoid, which releases the plunger when the current through the solenoid is in excess of the predetermined amount, thus allowing the tripping contacts to come together and trip the main breaker. The above relay is coupled to the circuit by means of series transformers. The number and method of connecting up these series transformers for operating the relays, depends upon the winding of the generator armature. For instance, with an armature star wound with mid point grounded, it would be necessary to install three series trans-connected in delta. In order to provide proper and efficient protection, it is, therefore, necessary to install discriminating devices similar in principle to those previously described. This has already been done on the more recent installations of the Metropolitan Underground and North Eastern Railways.

* * *

Important to Central Station Engineers.

In our next issue we shall commence a series of articles on the working of Central Station Plant. These will be written by an Engineer experienced in the handling of supply station machinery.

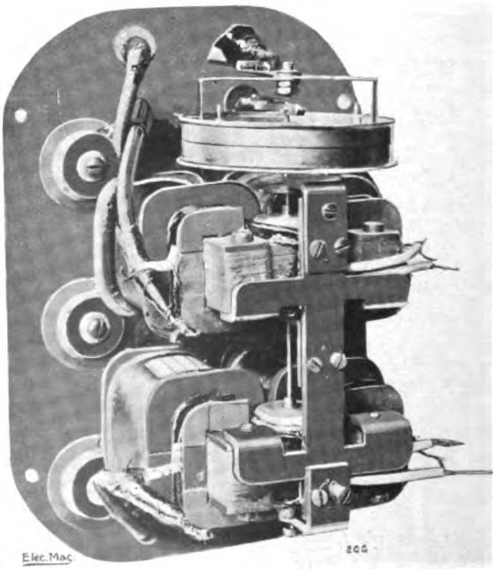


Fig. 9. Polyphase Reverser Current Relay.

BURNING PULVERISED COAL.

The question of economical and smokeless combustion of fuels for steam generating purposes attracts attention at all times, consequently the following details, taken from a long article on the subject in *Power*, will prove of interest.

The operation of feeding and burning dust coal is very simple. For the most successful systems it is reduced to a very fine powder by grinding and then introduced into a furnace lined with refractory material, heated to a sufficiently high temperature to ignite the fuel and burn it in suspension.

To obtain the best results in coal dust firing, the coal must be reduced to such a condition of fineness that 75 per cent. will pass a mesh of 40,000 per square inch, and 95 per cent., 10,000 per square inch. There are various types of grinders which will accomplish this result, but there are principally two systems. In the first the grinding is done in separate plants by large machines weighing many tons, the dust being then stored until required. In the second system the coal is reduced by breakers to about the size of hickory nuts, then conveyed to the pulverising and feeding apparatus in front of the boiler, where it is pulverised, and fed to the furnace with the required amount of air for combustion.

In the combustion of bituminous coal a large proportion of the valuable heating materials in the hydro-carbons are driven off when the coal is heated. To show approximately what this proportion is, a table of analysis of several kinds of good bituminous coal is given below.

	Volatile Matter.	Fixed Carbon.
Hocking Valley	32·80	53·15
Virginia	26·06	63·75
Kentucky	30·60	58·80
Blair Co.	26·72	60·77
Pittsburg Ocean Mine	39·09	57·33
Clarion Co.	38·60	54·15
Connellsville	30·10	59·61
Youghiogheny	36·49	59·05

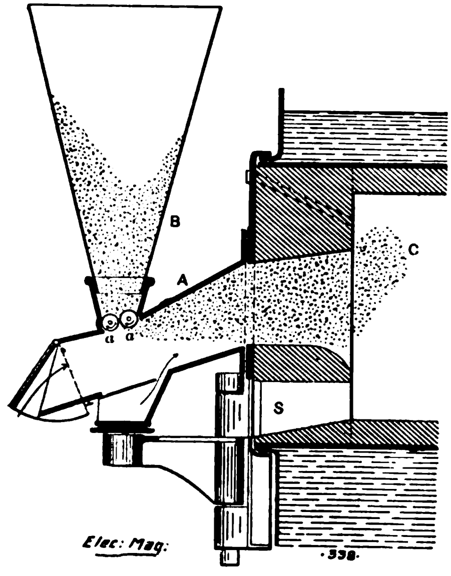


Fig. 1. Pinther System.

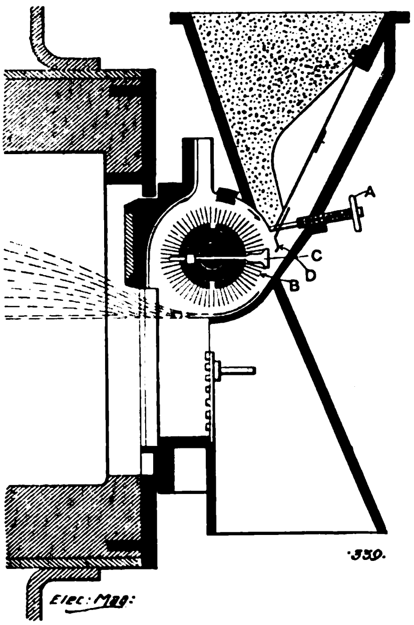


Fig. 2. Schwartzkopff System.

The Pinther coal-dust system shown in Fig. 1 is a feeding device coming under the head of natural draft powdered coal machines, and remarks are not necessary to show that it lacks the essentials that go to make up the perfect boiler stoker. The Schwartzkopff system (Fig. 2) is one of the simplest and most practical powdered coal feeders yet tried. The coal is first ground by a separate machine to the required fineness and placed in the hopper. The dust is delivered to the furnace by a revolving brush *B*. The regulation of the dust supply is effected by the hand-screw and the spring-plate bottom of the hopper. Coal dust, even when dry, will bridge over in almost all forms of hoppers, and in this process the brush has been fitted with a hammer shown at *C*. In the act of rotating, this hammer comes in contact with the plate *D*, agitates the dust and causes a steady, uniform flow to the revolving brush. It will be seen that this device delivers the dust to the combustion space and does not rely on the natural draft for this purpose. This reduces to some extent the bad effects of the fire. However, the oxygen for combustion is supplied by induced draft, the fuel must be ground, stored and handled before being placed in the hopper.

Day's pulveriser and fuel feeder, or, as latterly called, the "Ideal Fuel Feeder," differs from those described above that by one process it breaks up the coal, pulverises it, mixes it with air and delivers the mass into the furnace. The operation of the apparatus consists in keeping the hopper filled with coal, which is passed into a combined breaker and feeder constructed on the coffee-mill plan. This reduces the coal to about the size of the coffee bean. It then passes into the pulverising chamber. This machine is 30 inches in diameter and 24 inches long inside of the pulverising cylinder. The power for operating the apparatus is furnished

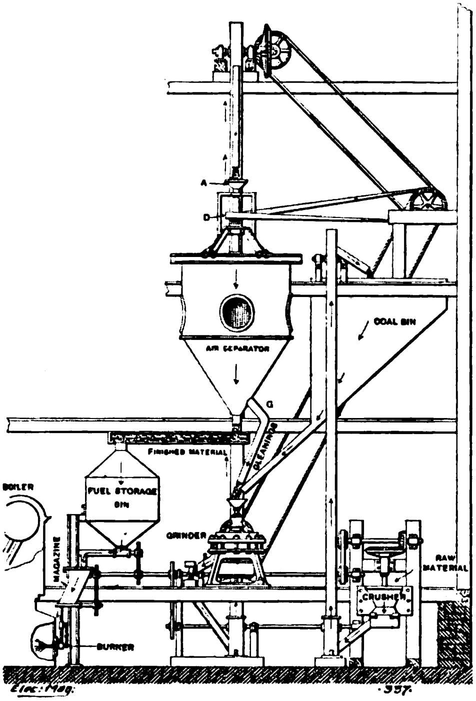


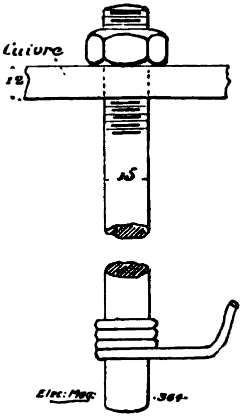
Fig. 3. Complete Coal Pulverising System.

by a small reciprocating engine, through a countershaft, bringing the revolutions per minute up to 550.

The Engineering and Powdered Fuel Company, of Philadelphia, devised a system for preparing and feeding coal dust which is shown in Fig. 3. The boiler performance shown in extensive trials with this system was excellent. The pulverisation was almost perfect. A sample of the powder passed 95 per cent. through a 150 mesh. While these trials show a high furnace efficiency, it is quite obvious that a complicated mechanism of this sort, involving as it does a compressed air plant in addition to that illustrated, would never become commercially popular as a stoker for steam generator.

A NOVEL RHEOSTAT.

During the reception trials of a 1,000 kw. 500 volt generator at the central station of Nancy, an original and very simple rheostat was used by the engineers in charge. A deal trough (4 x 1·5 x ·25 m.) was divided into 7 compartments by 6 vertical planks under which water was kept circulating. Between the planks, spirals of iron wire 3 mm. in diameter were placed, that of the spirals themselves being 6 cm. These were connected to two copper bars 60 mm. broad and 12 mm. thick placed just above the level of the water. The connection is illustrated in the accompanying figure; an iron bolt 15 mm. in diameter was screwed into the copper bar and fixed by a nut, the extremity of the iron wire being wound round and soldered to the lower part of the bolt, 20 cm. below the surface of the water. With 6 spirals, the output of current was as high as 1,660 ampères at 500 volts, or 276·67 ampères per spiral. This works out at 53·2 ampères per mm. diameter, as determined by the formula $I = kd.\frac{3}{4}$. The required length of wire for a pressure of 100 volts would be given by the formula $I = k_1d.\frac{1}{2}$, d being in both cases the diameter of the wire; k_1 is found to be equal to 6·88. The trials lasted 5½ hours without any signs of deterioration of the rheostat. Two fire-nozzles were used for the circulation of water, the supply being about 2 litres per second. The temperature of the inflowing water was about 17°C., and that of the outflowing 77°C., 2 (77-17) or 120 calories being thus carried away by the water. The power dissipated in the rheostat was 1,660 x 500 = 830,000w. or 200 calories per second. Part of the water was thus evidently vaporised. Now 560 calories are required for converting into steam a litre of water at 77°, which shows that ·143 litre were vapourised per second. During the trials the following figures were logged, which show the increase in resistance of the rheostat with the terminal P.D. and current intensity.



A Novel Rheostat.

Volts.	Ampères.	Ohms.
365	1,350	·270
418	1,400	·279
455	1,540	·295

Rational Design of Current Distributing Networks.

In the *Elektrotechnische Zeitschrift* (April 14th and 21st), Dr. E. Müllendorff suggests the following method of calculating current distributing systems in the case of the consuming places, and the central station being given :—

1. After choosing the feeding points, the natural fields of action of the latter should be determined.
2. After ascertaining whether any one of these ranges is of undue dimensions, a test should be made as to whether the feeding points coincide with the centres of gravity of the natural fields of action, taking into account the central station itself.
3. The cross sections of the conductor in each field of action are calculated according to the simple method of current moments, this serving to determine the available minimum amount of conductive copper.
4. In the case of the cross sections having to be simplified, the definite cross sections are determined from the natural cross sections, when the definite current distribution is calculated. The point of maximum absolute tension loss will, in each independent portion of the network, determine the definite cross sections themselves.
5. The conductive material thus calculated should be compared with the minimum calculated in advance. In the case of a satisfactory agreement, a simplification of the cross sections will be possible, while a poor agreement will point to the necessity of a better adaptation to the natural crosssections.

This method is valuable on account of the permanent checking of the amount of copper expended, as well as of the simplicity with which this is made possible.

ELECTRICAL · WORK and · PRACTICE in · the · Shops

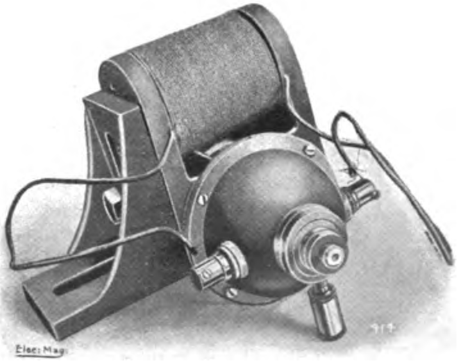
The Artisan's Section.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike, which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

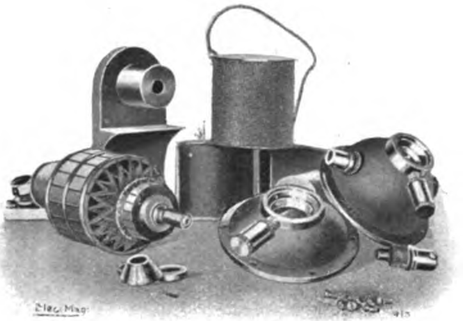
* * *

An Electric Grinder.

In our March issue we described a small electric grinder, giving details of the construction of the same. These were taken from the *American Machinist*, and in our contemporary the following further particulars have recently appeared. Fig. 2 of the original article shows a cross-section of the armature, field and field core with the bonnets or armature supports left off. These bonnets must be made of brass or some other non-magnetic metal. The armature slots are not shown in this illustration. The field core is round, 1⅞ inches in diameter by 3⅝ inches long. The voltage is 110 direct current. The 24 gauge metal of the armature discs is ·025 thick; consequently a pile 2⅜ inches thick would nominally contain 95 plates. After shellacing, the discs will be somewhat thicker and a few less will be required. For armature varnish mix ground asbestos with shellac, using about one ounce of asbestos to each half pint. This improves the insulating quality of the varnish and keeps down the heat caused by the eddy currents in the armature. The amount of No. 23 wire for the armature will be approximately 410 feet. The field spool dimensions are: Diameter, 3¼ inches; length, 3⅝ inches; bore, 1⅞ inches. Make the ends of the spool of fibre 1-16 thick and the tube of fibre 1-64 thick. Wind the spool very nearly full—say, within 1-16—and use the space left for the cotton cord protector covering. As No. 29 wire is ·01135 inch diameter and the insulation will be about ·010 thick, the external diameter, including insulation, will be about ·021 inch. As the spool is 3½ inches between flanges, there would be 166 turns in each layer of the field winding if the winding were absolutely even. As the depth of the spool flange is 11-16 inch while 1-16 was left for the final covering and the spool tube was 1-64 inch thick, the space left for wire would provide for 27 layers. The extreme diameter of the winding being 3⅛ inches and inside diameter 1 29-32 inches, the mean diameter was 2½ inches, giving a mean circumference of 7·854 inches. The number of turns per layer, 166, multiplied by the number of layers, 27, multiplied by the mean circumference, 7·854 inches, would give a total length of 33,945 inches, or 2,829 feet. Absolute uniformity in winding is not essential. If not wound evenly, the spool will hold a little less wire and the field will absorb more current, but this will have no appreciable



Electric Grinder, Complete.

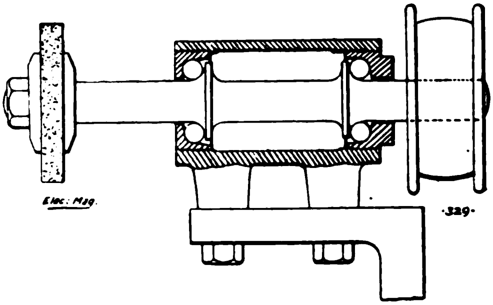


Parts of Electric Grinder.

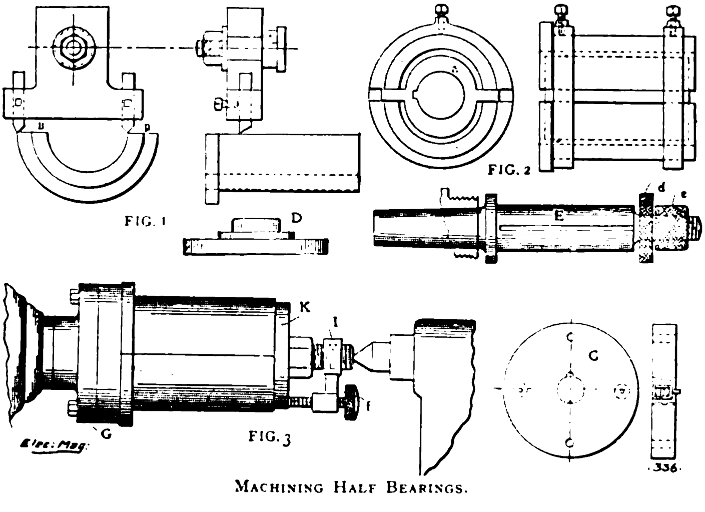
effect on the running of the motor. The discrepancy in the figures for the diameter of the left-hand cone shown in Figs. 1 and 2 was due to an oversight in checking. The correct figure is 1¾ inches. The photographs reproduced were taken from a machine somewhat smaller than the one described, but almost identical in design and construction. The armature of this machine is 3 inches diameter by 2½ inches long. The complete machine weighs 15 pounds, and will drive a 6-inch diameter wheel, taking any cut that the wheel will stand.

MACHINING HALF BEARINGS.[*]

The sketches show a method of machining bronze boxes cast in halves. The castings are first clamped in a chuck on the shaper, and Fig. 1 shows a tool-holder used for facing both edges of the casting at once. The holder is clamped to the clapper of the shaper by bolt *A*, which takes the place of the usual tool-post. The tools, which are of ⅜ in. square steel, being properly set, are made to plane the bearings on faces *B B* simultaneously. Fig. 2 shows a fixture on which these bearings are then clamped by the two ring clamps. To centre the bearings the fixture *a* is set upon end over block *D* and the half boxes on each side of it, which admits of equal clearance when facing the opposite ends. The fixture *a* with the half bearings clamped thereon is then placed on the arbor *E*, which is held in the taper hole in the lathe spindle, the tailstock being kept back out of the way, as there is no other support required. Slip-washer *d* is put in place and lightly clamped by knurled nut *e*, the outside of which is smaller than the hole in *a*. The ends of the bearings are then faced to the required length. Fig. 6 shows the fixture on which these bearings are turned, the tools being held in a turret tool-post which has been previously described. Two cuts are taken, roughing and finishing. *G* is a plate fastened to the lathe face-plate as shown, and into which the stud *H* is screwed a tight fit. being secured by a little pin driven in the end. The sides of the two dowels are located on the centre line, and they are held forward by springs, as shown. The flange of one of the half bearings is set against plate *G*, and the planed faces *B B* are set against the sides of the dowels. The knurled screw *f* is tightened and holds this half bearing in place. The other half bearing is now put in place, the spring dowels receding. Slip-washer *K* is slipped over stud *H*, straddling the point of screw *f*, and is tightened with the nut, as shown. The bearings are now held in a central position and ready to be turned. The arm *I* in which screw *f* is located is a tight fit on stud *H*, revolving with the lathe, and in no way interferes with the turning tools. After turning these bearings they are bored in a horizontal boring and drilling machine.



Tool-Post Grinder *(see below.)*



Machining Half Bearings.

A Cheap Tool-Post Grinder.[*]

A cheap effective grinder made by myself two years ago from an old pattern cycle bracket is described herewith. It was used to grind rings for free wheels. The holes for the stays were plugged, and the bracket was bolted to an angle piece, which was fastened in the tool post as usual. (See illustration above). E. T.

---

[*] *American Machinist.*

[*] *American Machinist.*

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrcial trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

The Effects of Preferential Trade with Canada.

By the ASSOCIATE EDITOR.

We have previously pointed out* that before the adoption of the preferential tariff the purchases of Canada from the United Kingdom were steadily diminishing, and that the practical effect of the preferential tariff was a marked increase in such purchases, an increase which was still more marked after the further reduction in the rate of duty. This matter is of so much interest to all who desire to strengthen the commercial relations between the Mother Country and other States in the Empire that we make no apology in presenting to the attention of our readers some further figures which are now available. The returns for the last six months, ending December 31st, 1903, warrant the conclusion that the record year of 1873 will be closely approached, and possibly surpassed by the year ending at the end of June next.

The following table shows in a very striking manner the benefit to British exporters that has resulted from a diminution of the import duties during the years 1901-3.

From this table it becomes evident that not only has the total volume of business increased by £2,101,834 since 1900, but that the monetary value of the abatement of duty for the three years has been £1,692,918, giving to British Exporters an advantage to this extent over their foreign aspirants for Canadian trade. It may be mentioned also that a corresponding advantage has accrued to the owners of British vessels, as may be judged by the following figures :—

Year.	Tonnage of goods brought into Canada by British ships.	British Ships engaged in Export Trade to Canada.		
		No.	Tonnage.	Seamen.
1897	708,579	967	1,799,841	46,033
1903	1,619,788	2,379	4,092,286	108,842

Here we find an increase of 146 per cent. in the number of British vessels carrying cargo to Canada, 127·4 per cent. in the tonnage employed, 128·7 per cent. in the cargo carried,

VALUE OF DUTIABLE GOODS IMPORTED INTO CANADA FROM GREAT BRITAIN UNDER GENERAL AND PREFERENTIAL TARIFFS, 1901—1903.

Year ended June 30th.	Imports under General Tariff.		Imports under Preferential Tariff.		Duty that would have been payable on Col. 3 had no preference been given.	Difference in favour of Great Britain due to Preference.
	1 Value.	2 Duty Paid.	3 Value.	4 Duty Paid.		
1901	£1,159,186	£563,812	£5,181,012	£1,005,269	£1,507,904	£502,634
1902	£1,266,435	£605,818	£5,746,078	£1,079,120	£1,618,680	£539,560
1903	£1,409,282	£666,876	£7,032,751	£1,301,449	£1,952,174	£650,724
	£3,834,903	£1,836,506	£17,959,841	£3,385,838	£5,078,758	£1,692,918

---

* *The Electrical Magazine*, Vol. I., No. 3, p. 319.

and nearly 137 per cent. in the number of seamen employed.

More important still are the figures showing the effect of the preferential tariff upon the exports of iron and steel to Canada. For the years 1895-7 the total value of such exports was £1,266,027, and for the years 1901-3, £2,740,989. Apart from the satisfactory increase here indicated, it may be remarked that the growth was progressive during 1901-3, a condition which did not characterise the former period. Germany is the most determined European competitor of Great Britain in Canada, and strong efforts have no doubt been made by German exporters to retain trade relations in spite of a surtax of 33⅓ per cent. The practical effect of this surtax, however, has been a decrease of German exports to Canada from £1,216,605 to £991,722 in the latter half of the year 1903.

So far as the United States is concerned we have a competitor in close proximity to the Canadian market, and possessing an intimate knowledge of trade requirements. But the position is that while American goods have to pay a duty of 28 per cent., our goods are only subject to an impost of 19 per cent., and the difference should have the effect of counterbalancing geographical advantages to a considerable degree. Even if they do not entirely conduce to this end, it must be admitted that the British manufacturer is more nearly on level terms with his competitor in the United States than at any previous period.

In one important respect, however, reform is urgently required. British newspapers and journals, containing the advertisements that do so much to promote trade, do not circulate to any appreciable extent in Canada, owing to the adverse postal rates established by the Government. The United States newspapers, having to pay a merely nominal rate of postage, are almost universal in Canada, and this fact constitutes a great advantage to the American manufacturer. We feel sure that more liberal treatment in this matter would far more than compensate for any trifling loss of postal revenue by a greatly increased demand for British manufactures in the Dominion.

Opportunities in Mexico.

(By our Special Correspondent.)

[British manufacturers will do well to study the remarks of our Mexican correspondent. Despite the distance, he anticipates no difficulty in the placing of orders with English firms. Goods can be almost as quickly delivered from London as from New York. Details are furnished in another column.—Ed.]

The possibilities for electrical development for power, traction, and illuminating purposes in this republic are beyond computation, and, it may be assumed, no other country presents a similar field so wide in scope.

There are many reasons for this. The numerous waterfalls, which are to be found all over the country, whose wasting power—fabulous in its enormous extent—invites utilisation. The scarcity of fuel for manufacturing purposes, and the high cost of that which is available, cutting deeply into the profits of factory owners, would emphasise the urgency which calls for the harnessing of the rushing waters to create electrical force. Manufacturing and mining enterprises are retarded owing to the high cost of fuel and transportation expenses, notwithstanding that practically all of these enterprises are easily accessible to the introduction of electricity, due to the proximity of water power. The introduction of electrical power and light in Mexico is proceeding slowly, and while some of the leading cities are well equipped in this respect, a beginning has scarcely been made. Electrical traction is needed in every city in Mexico outside the metropolis. It can be accepted as a fact that every town in the republic of any pretensions aspires to owning electric plants for light and power purposes. The proportion of those which already own electric plants is small. In the eight months ending with February of the current fiscal year, Mexico imported more machinery from the United States for electrical appliances than Germany and France combined. During the eight months referred to, Germany purchased electrical machinery from the United States to the value of $36,027, France purchased $64,388, and Mexico $350,000. (These figures represent gold currency.)

Railroads are rapidly opening up the country, and, as each new line is the forerunner of manufacturing and mining enterprises in districts hitherto inaccessible for transportation purposes, the demand for electrical machinery for power, light, and traction will proceed and increase in volume indefinitely.

English houses in electrical lines are but little—if at all—represented in Mexico, with the result that trade which is solicited and followed up by Americans and finally obtained, would, under similar conditions, find its way to London, Liverpool, or some other important city in England. Notwithstanding that the United States is the next door neighbour of Mexico, there is very little difference in time in the matter of receiving goods from London or New York.

An additionally encouraging feature of recent legislation in Mexico consists in the modification of Custom House regulations, which heretofore were harsh and rigorous. Much of the red tape—characteristic of Latin countries—is now a thing of the past in Mexico, and shipments can be made from England to the republic with a degree of promptness on this side which speaks well for the progressive spirit which prevails. J. B.

TRADE NOTES.

Duty on Electrical Machinery in Sweden.

On April 7th, the Riksdag, at Stockholm, passed a Bill imposing an ad valorem duty of 15 per cent. on electrical machinery.

The Canadian General Electric Company.

We learn from a recent report of the Directors that the Canadian General Electric Company has had another successful year, the profits for the year being £102,442 3s. out of which two half-yearly dividends amounting to £61,806 3s. were paid. Of the balance the sum of £20,626 10s. was written off for depreciation, £2,000 transferred to reserve, and £9 10s. added to credit of profit and loss account, which now stands at £16,152. The total surplus is now £269,108. A satisfactory feature of the year's business was the amount of unfinished contracts on hand at the beginning of the new year which were in various stages of completion, but on which no profit had been taken when the books were closed. In 1897, the value of contracts thus carried forward was £48,000, in 1900, it had increased to £112,600, and in January of 1904, it was £550,000. In the electrical department of the company several of the largest generators in the world are in course of construction for Niagara Falls, each with a capacity of 12,000 h.p.; also two Curtis steam turbines direct connected to electric generators, of 2,500 h.p. each, as well as a number of smaller sizes. The Peterboro' works of the company cover an area of 40 acres, of which 18 acres are covered by buildings, and it may be mentioned that the main machine shop of the Montreal works comprises upwards of some 65,000 sq. ft. of floor space devoted to the manufacture of electrical machinery.

SOME CONTRACTS OF THE MONTH.

Power.

Llangollen and District Electric Light and Power Co.: Steam dynamos and booster, Crompton and Co; Boilers and water-heaters, Hornsby and Co.; Pumps, Blake and Knowles; Switchboard, General Electric Co.

Glasgow Corporation: Mains, cables, switchboard, distribution boards, wiring and accessories, £2,705 2s. 5d.; Archibald Low.

Salford: Motors of 5-h.p. and upwards for the ensuing year, Lancashire Dynamo and Motor Co., Ltd.

Wimbledon District Council: Cables, Callender's Cable Co., & St. Helen's Cable Co.; Joint boxes and jointing materials, Calender's Cable Co., and Prestwitch & Burt.

Johannesburg Municipal Electricity Works: Supply and erection of a number of 1,000 h.p. and 2,000 h.p. gas engines, Wm. Beardmore & Co.

Stepney Borough Council: Extensions to the generating station building, £12,921; Mr. B. E. Nightingale.

St Pancras Electricity Committee: Two 1000-kw. steam turbines, £14,000; C. A. Parsons & Co.

New Golden Gate Gold Mining Co., Tasmania: Electric pumping plant, £2,151; Siemens Bros. & Co.

Consett Iron Co., Weardale Coal, Coke and Steel Co, and Silkstone Colliery: Electric pumping installations, Ernest Scott and Mountain

Stourbridge Urban District Council: Battery, £1,100; Electrical Power Storage Co.

Canterbury Town Council: Accumulators, £565; Pritchetts & Gold.

Dewsbury Town Council: Renewal of battery at electricity works, Tudor Accumulator Co.

Hull Town Council: Switchboard for Trippett Telephone Exchange, International Electrical Co.

Battersea Borough Council: Cables &c. for stock, £2,624; and street boxes, £518 16s. 8d; Callender's Cable Co.; spare armature, £700, C. A, Parsons & Co.

Glasgow Electricity Committee: Switchboards for Port Dundas station, £5,200; Witting, Eborall & Co.

Gravesend Town Council: Demand indicators, Reason Manufacturing Co.; meters, Ferranti.

London County Council: Additional low-tension switchboard at Elephant and Castle sub-station, Bertram Thomas.

Loughborough Town Council: Supply and maintenance of storage battery, £1,165; Pritchetts and Gold.

Swindon Town Council: Electric fittings for ensuing year, Edwards, Bags & Rye.

Poplar Electricity Committee: Switchboards and gear, £3,978, 10s; Cowans, Ltd.

Newport Electricity and Tramways Committee: Booster and battery milking booster, £418 6s.; Johnson & Phillips, Ltd.; switchboards and instruments, £463; Alger & Sons; cables, £2,602; Johnson and Phillips, Ltd.

Wimbledon District Council: Meters, Electrical Co.; Arc lamp carbons, General Electric Co.

Gravesend Town Council: Incandescent lamps, Electrical Co.

Ipswich Council: 5,000 yards of lighting mains, and 200 yards of cable for services, £895 5s.; Johnson & Phillips.

Traction and Transport.

Handsworth Urban District Council: Construction and electrification of the tramways, £9,945, Mr. George Holloway.

Keighley Tramways and Electricity Joint Committee: Rails, £4,971; P. & W. MacLellan, Ltd.; points and crossings, £1,179; Hadleigh's Steel Foundry Co., Ltd.; Overhead equipment, £2,960; Blackwell & Co.; cables, £1,690; W. T. Glover & Co, Ltd.

Gosport (The Provincial Tramways Co.): Power station, £5,435; Mr. H. C. Sweetland

Christchurch Tramways Board: Installation of electric tramways, New Zealand Electrical Construction Co.

London County Council: Cables for electric traction of tramways in Southwark and Bermondsey; Siemens Brothers & Co.

Lancaster Council. New tramway route and the doubling of a portion of the existing track, R. W. Blackwell & Co.

Lighting and Heating.

Gloucester Town Council: 123 arc lamps, £1,393 12s. 6d; Gilbert Arc Lamp Co., Ltd.; maintenance of new battery for ten years, £900; Electrical Power Storage Co., Ltd.

Great Central Railway: Annual supply of lamps, Sunbeam Lamp Co.

Hackney Guardians: Electrtc lighting of the new casual wards, £570; Jackson Bros.; electrically lighting buildings in course of erection, £661 19s. 10d.; G. E. Taylor & Co.; and £579; Electrical and General Engineering Corporation Co.

Hereford Asylum: Re-wiring, £2,187; W. J. Fryer & Co.

India Office: High voltage lamps, Sir Hiram Maxim Electrical & Engineering Co.

Belfast: Electric wiring new city hall, W. Coates & Son, Ltd.

Faversham District Council: Wiring Town Hall, H. S. Tett & Co.

Glasgow sub-committee of the Cleansing Department: Electric light installation at Crawford Street works and stables, £936 7s.; W. Harvie & Co, Ltd. (recommended); electric light in Partick sewage works, W. C. Martin & Co, (recommended).

Swansea Corporation: Arc lamps, Oliver and Co., Ltd.

War Office Army Council: Electric telescope lamps, Sir Hiram Maxim Electrical and Engineering Co., Ltd.

Grimsby Education Committee: Wiring and supply of fittings for the electric installation for Schools, District Electric Co.

BUSINESS ITEMS.

Geipel & Lange. The Secretary of the Army Council, War Office, London, S.W., has placed a contract with Messrs. Geipel & Lange, Vulcan Works, St. Thomas' St, Southwark, S E., for 51 Geipel's Steam Traps, this being the third repeat order, for the Royal Gunpowder Factory, Waltham Abbey. This makes a total of 147 Geipel Traps in use there.

Messrs. Scott & Mountain, Close Works, Newcastle. Electrical Pumping Installation. Two 550 h.p. steam units, three 130 h.p. motor pumps, switchboards, cables, etc., Consett Iron Co., Blackhill. Electrical pumping installation, 600 h.p. generator, three 140 h.p. motor pumps, Weardale Coal Co. (Croxdale), near Durham. Pumping and hauling plant, one 220 h p. steam unit, one 25 h.p. hauling motor, two 10 h.p. motor pumps, Old Silkstone Colliery, near Barnsley.

(Continued next page.)

Motor Generators for Johannesburg. Messrs. Mather & Platt, Ltd., of Salford Iron Works, Manchester, have just received the order for three exactly similar sets of motor generators, and for a third pair of dynamos, for use at Johannesburg Electricity Works. Each set comprises a 250 kw. two-phase alternator for a current at 3,300 volts, 50 cyles, coupled to a pair of 150 kw. continuous current dynamos, for pressures from 230 to 275 volts. Each set will be driven from an Allen steam engine, provision being made for disconnecting the continuous current dynamos from the alternator if desired. The engine will be removed later altogether, when current from the tramway or lighting mains will be supplied to the continuous current dynamos in series, and they will drive the alternator; or two-phase current being supplied to the alternator, the dynamos driven by it will be used, either in series for supplying current to the tramways, or as balancers on the three wire lighting system. The extra pair of continuous current dynamos will be precisely similar to those above described; and used as balancers on the three wire system.

BUSINESS OPPORTUNITIES ABOARD.

MEXICO.

THE capital of the State of Chiapas, Tuxtla Gutierrez, will increase its lighting facilities to the extent of 2,000 incandescent lights and 60 arc lights of 2,000 candle power each. ***Address, General Rafael Pimentel.***

Mexico. The electric street railroad system of Mexico City, which for equipment and excellent service is not surpassed on this hemisphere, will materially extend its lines in several directions. The entire equipment is of English make. Negotiations are now pending to purchase power from the Mexican Light and Power Co., with the object of abolishing the immense and costly steam plant. The Mexican Light and Power Co. is controlled by Canadian capitalists. When it completes its plant at Nexaca Falls, will furnish high tension current at 6,000 volts, with rotary converters in sub-stations. The company operating the electric street railway system of this city will also abandon the six remaining mule traction lines and replace them with electric cars and equipment. ***Address, W. W. Wheatley, Federal District Company, Mexico City.***

THE city of Guadalajara will largely increase its present electric light capacity. ***Address, Coronel Don Miguel Ohumada, Guadalajara Jalisco.***

THE horse tramways of Hermosillo, capital of Sonora, will be abolished and electricity introduced for traction as well as power. An American company has offered the city 2,000,000 dols. for the purchase of the present system as it stands with the understanding that electric conveyances, together with electric plant, be installed. ***Address, Don Rafael Izabel, Hermosillo.***

THE falls of El Salto de Santa Anna, Lagos, Jalisco, will be utilised to generate electric power. ***Address, Jefe Politico Margarito Gonzalez Rubio, Lagos, Jalisco.***

The Tepic City Council is maturing a project to establish an electric light plant and within a few weeks bids will be called for. ***Address, General Pablo Rocha J. Portu, Tepic.***

THE Mexican Railway Company has made formal application to the Government for permission to establish electric traction in the section of its road known as Las Cumbres de Maltrata, where the heavy grade requires two locomotives to haul an ordinary passenger train. The electric power will be generated at a large waterfall on the Atoyac River. This road was constructed by English capitalists, and was the first to operate in Mexico. The entire equipment is of English make. ***Address, Marlborough Pryor, President of the Railroad, Mexican Railroad Company, London.***

THE cities of Mexico and Puebla, distant from each other 80 miles, will be connected by an electric railway, which will pass along the base of the famous Popocatepetl Mountain. ***Address, Secretary of Communications, Government Palace, Mexico City.***

THE cities of Morelia and Guadalajara will be connected by an electric railroad; distance 120 miles. Archbishop Silva, of Morelia, is interested. ***Address, Engineer Carlos F. de Laudero, Morelia, Michoacan.***

OF the abundance of water power with which Mexico is supplied, it is estimated that at present not more than 250,000 horse power are actually in use or in course of development.

THE average cost of power derived from steam in Mexico City per horse power per year is approximately between 150 dols. and 225 dols. Mexican silver, while the cost for electricity producing the same power is from 120 dols. to 125 dols.

Electrical Goods Exported during March and April, 1904.

Town	March £	April £
Adelaide	224	122
Aden	288	—
Alexandria	579	853
Amsterdam	265	241
Antwerp	396	—
Autofagasta	80	—
Auckland	546	470
Bangkok	114	35
Bombay	1179	4380
Bremen	110	50
Brisbane	175	40
Brussels	—	250
Buenos Ayres	1004	2898
Cairn	—	200
Calcutta	2033	1527
Callao	93	—
Cape Town	3513	4879
Carlskrona	—	210
Colombo	567	281
Copenhagen	—	240
Delagoa Bay	3580	441
Durban	7163	5705
East London	2416	2368
Flushing	—	51
Fremantle	335	125
Genoa	—	100
Ghent	—	20
Gibraltar	5952	839
Gothenburg	51	—
Granada	27	—
Halifax	90	—
Hamburg	457	217
Hobart	—	79
Hong Kong	1198	499
Karachi	103	—
Kobe	—	268
Launceston	326	156
Libau	—	22
Lisbon	444	469
Lyttelton	199	55
Madras	1124	816
Malta	190	42
Manila	—	40
Marmugoa	—	128
Mauritius	184	165
Melbourne	410	525
Nagasaki	—	756
New York	620	—
Odessa	—	270
Oporto	1869	2627
Ostend	17	—
Otago	754	2560
Paris	1296	3068
Penang	10	614
Pernambuco	—	126
Perth	667	1248
Piroeus	—	556
Port Elizabeth	1971	2659
Rio Janeiro	3072	370
Rosario	1302	141
Rotterdam	12	167
Saigon	—	150
St. John	78	—
St. Petersburg	110	400
Santos	—	660
Sarawak	—	135
Seville	26	—
Seychelles	179	26
Shanghai	1403	2014
Sierra Leone	48	—
Singapore	3979	793
Smyrna	23	—
Stockholm	33	380
Suez	—	225
Sulina Cruz	14	14
Sydney	1200	3985
Tientsin	22	26
Tokio	82	419
Valparaiso	84	—
Vera Cruz	21	—
Vigo	—	165
Wellington	3231	5114
Yokohama	2818	3011

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

◆

Local Indebtedness.

By the ASSOCIATE EDITOR.

THE speech of the Chancellor of the Exchequer, in introducing his Budget last month, contained some very pertinent remarks on the extraordinary increase of local indebtedness in recent years. The figures he gave, though familiar to many who, like ourselves, have paid attention to the subject and have pointed out the growing evil, are certainly alarming, and we hope they may lead the general public to think about the matter. It is certainly one which calls for the serious consideration of everyone who takes an interest in the financial position of his country. Our National Debt is at the present moment at a large figure, but it is very much less now than it was ten or twenty years ago. Successive Chancellors have succeeded in reducing our national financial liabilities in the twenty years (1880-1900) by no less than £137,000,000, and that, by itself, would be a hopeful sign; but while the Treasury has been economising and reducing debt, the municipalities have been piling up debt in the most reckless fashion, with the consequence that in the same twenty years there has been an increase of debt incurred by the local authorities of England and Wales alone amounting to no less than £157,000,000.

THE EFFECT ON THE MARKET.

EVERYONE knows that the money market has of late been in a state of stagnation, and that even the best securities have been affected. What is the cause? The Government has been blamed in many quarters, and it has been said that national borrowings have made money dear, and have created this unsatisfactory situation. But this is not the main cause, and the Chancellor of the Exchequer was not slow to state the truth. It is the local authorities who have spoilt the market, by their interminable borrowing for every kind of undertaking. They have created an uneasy feeling in financial circles, and they are now suffering from the depression they have produced, as, on going into the market for more money, they are compelled to offer a high rate of interest, and in some cases to do without the money, as the public will not give it. It has been stated, with what truth we do not know, that at the present time some municipalities are actually in the power of their banks, and are being "run" by them.

MUNICIPAL ASSETS.

MOST people will recognise that this state of affairs is highly dangerous both to the nation and to the municipalities themselves; but some will say that, although the increase of local indebtedness is very great, yet it is not dangerous, as there are valuable assets to place on the other side of the account. A municipality, we are told, has something to show for the money it has borrowed. This is, no doubt, true, but we must see what the "something" is; and here it becomes necessary to distinguish between the undertakings for which debt is incurred. Parliament has imposed upon the local authorities many important duties, such as those under the Public Health Acts. For the fulfilment of these duties money is necessary and has to be borrowed, and if the duties are well performed, the money may be considered well spent, even

H

if there should be no bricks and mortar to show for it. In so far, therefore, as money is spent upon proper municipal works, made compulsory by Parliament, we make no objection to the borrowing; but these are responsible for the minor part of the municipal debt which has accumulated in recent years. Of late years, what is called "municipal enterprise" has come to the front, and local authorities have, with the sanction of Parliament, entered upon all sorts of trading undertakings. What is the nature of the assets of these undertakings? They are in no way different from those of similar undertakings carried on by private companies: they are "wasting assets." Each year they become less valuable; but while a private company provides for this by proper depreciation allowances, very few local authorities think depreciation worth considering at all, and consequently they leave it out of their books. Thus even if there be originally assets up to the full value of the money spent on them, the capital value becomes less and less, and at the end of the period for which the loan was granted there is nothing at all to show for the money, and a fresh loan has to be incurred. And if, as frequently happens, any of these trading undertakings be carried on at a loss, the ratepayers have an extra burden thrown upon their shoulders, and must perforce go on paying interest and sinking fund charges till the whole debt is redeemed. Of course, local authorities never consider the possibility of a loss on their undertakings; the pictures they paint before the eyes of the electorate are always in bright colours, and that called "Profits for the relief of rates" seldom fails to produce the desired effects. Truly, the British ratepayer is slow of understanding, or he would long ago have inquired how it happens that, in spite of all these new undertakings which are supposed to be so profitable, the rates are steadily increasing. Even the slowest intellect, however, may in time grasp the situation, and signs are not wanting that a real awakening is now taking place.

THE DUTY OF PARLIAMENT.

THE whole blame for the present situation cannot be properly laid on the local authorities. Parliament has not compelled them to undertake these trading enterprises, but it has given its sanction to them, and has even aided them by State loans. The manner in which these loans have been granted has always appeared to us to be open to severe criticism, and we are, therefore, pleased to note that the Chancellor of the Exchequer means to alter all this, and to surround State loans in future with careful restrictions. This will have a good effect, as it will check extravagance; but we hope Parliament, as the legislative authority, will go to the root of the matter by restricting the sphere of municipal activity. The harm done by the present system is nowhere more fully realised than in the electrical industry, as electricity seems to possess an irresistible attraction for municipal bodies. Electric lighting and electric tramways they have tried to monopolise, and now they are adding telephones to the number of their undertakings. Perhaps the Marylebone fiasco may be a lesson to some; but Parliament ought not to delay action till municipalities begin to become bankrupt.

* * *

THE FATE OF THE POWER BILLS.

THE power schemes placed before Parliament this year are of great importance, but the prospect of their ultimate authorisation is now far from promising, if we may judge by the fate of the first of the number to come before a committee. Two Bills have already been rejected. These are the East London and Lower Thames Electric Power Bill and the Cheshire Electricity and Power Gas Bill. This is not a good omen for those which come up later for consideration, and it may be that, by the time this paragraph is published, other bills may have met the same fate. We shall be sorry if this proves to be the case, but the attitude of the committee on the question of finance in the two schemes referred to, compels us to face this possibility.

The Financing of Power Schemes.

We recognise fully that a committee ought to inquire most carefully into the financial prospects of any scheme submitted to it. No one could be less desirous than we are to see Parliament give its sanction to schemes which are financially unsound, as we are strongly of opinion that such schemes can do an enormous amount of harm to the electrical industry by alienating the sympathy of the public. If, then, the decision of the committee on the Cheshire and East London schemes was based on the conviction that the promoters had not given satisfactory evidence of being able to carry them to a successful issue, we have no fault to find. But a careful study of the reports of the evidence, and especially of the questions asked by members of the committee, gives us the impression that in one respect, at least, the attitude of the committee was too severe. The committee seems to have taken the view that the promoters should not only be able to show a reasonable prospect of the capital being forthcoming, but should give an absolute guarantee for the full amount required, and this appears to us to be unreasonable. In the first place, if a man gave a guarantee for a portion of the capital before the scheme came before Parliament, that guarantee would refer to the scheme as it appeared in the original bill; but the bill in its final form on issuing from committee may be a very different thing—so different in fact that the original guarantee would not apply. A wise man wants to know the exact scope of a scheme before he gives an absolute guarantee of money for it, and he cannot know that till the bill has passed through Parliament. Therefore it appears to us that to insist upon having a guarantee for the capital before considering the clauses and afterwards to proceed to cut up the bill and strike out or alter clauses is a wrong method of procedure, as the original guarantee then becomes useless and unenforceable.

The Position of the Contractor.

There is, however, another point to be noticed. Where entirely new schemes are brought forward, the public is sometimes reluctant at first to put money in them, and the promoters have to depend on persons interested in the industry. Among these are the contractors on the look-out for large orders. Hence it happens that in some cases manufacturing firms, in order to secure the contract for the supply of the machinery and plant for the installation, are willing to accept part payment in shares in the undertaking and to await its development for their remuneration. If, then, the capital is to be guaranteed, it becomes necessary to have arrangements made with a practical firm or firms before the scheme is considered in committee—that is, before it is known what the final form of the scheme is to be. This involves a loss of economy, as it practically prevents the placing of the contract on competitive tenders. If tenders were invited on the final scheme with an intimation that offers should also be made as to terms of payment either by underwriting some of the capital or by taking shares, competition in the industry is sufficiently keen to ensure applications; but if a bargain has to be made privately beforehand with a particular firm regarding a scheme which may afterwards be mutilated and curtailed, it is quite certain that the result will be more costly to the promoters and ultimately to the public. These considerations ought to be kept in mind, and we hope that committees will be satisfied with a reasonable prospect of the necessary capital being obtained for the schemes which come before them. If even this was wanting in the case of the schemes which have been rejected, then we do not regret that rejection, and our remarks here are only directed to what seemed to us to be in the minds of the committee.

Mond Gas.

In the case of the Cheshire scheme, the fact that Mond Gas was to be used in distribution appears to have been against it. One such scheme has already been authorised, but so far it has not been carried out nor have any pipes been laid. In view of this fact, the committee—as is evident from a question put to a witness—has been of opinion that people will hardly be found ready to put their money into a new scheme of the same order, and therefore rejected the bill. This attitude is perfectly justifiable, and in the interests of progress we hope no effort will be spared by the South Staffordshire Mond Gas Company to push on their scheme to a successful issue. Until that is done promoters must be chary of adopting the same means of distribution.

FINANCIAL NOTES.

Tramways in the City.

In this connection it is interesting to note the evidence given before the Traffic Commission by Mr. Bates, Chief Clerk in the Public Health Department of the Corporation of London. The City Council has always opposed the admission of tramways within the City boundaries, and this attitude is fully justified by the figures Mr. Bates gave to the Commission as a result of a census of the traffic on the main thoroughfares. Leaving aside altogether the enormous crowds of pedestrians, we find the number of vehicles passing through different streets in twelve hours estimated as follows:

Holborn	15,107	Fleet Street	11,133
Cheapside	11,902	Victoria Embankmt.	10,152
Holborn Viaduct ...	11,276	Queen Victoria St.	9,444
Newgate Street ...	11,133	Aldgate High Street	8,708

Even in face of these figures it may, of course, still be possible for officials of the County Council to say that to add tramcars to the present congestion would be "no disadvantage to the cars." But we venture to believe that impartial critics, who study the question carefully, will agree with Mr. Bates that it would be physically impossible to work tramways in the city.

Car v. 'Bus.

And the position is much the same in the thoroughfares outside the city. The motor omnibus, electric or otherwise, may possibly ere long replace the present horse-drawn 'bus; but in our desire to remove an evil, let us not hastily adopt a "remedy" which would make things worse than before. In crowded streets the "passing power" of vehicles is of much greater importance for the relief of congestion than their carrying capacity. For that reason tramcars, which have no passing power, but monopolise half the street, are quite inferior to 'buses or motor cars, and under the circumstances their huge size is a source of trouble rather than a convenience.

L.C.C. Tramways.

Once again has the attempt of the London County Council to obtain powers for a tramway down Tottenham Court Road to Oxford Street been defeated. In former years the proposal has usually been withdrawn before the Committee stage through want of statutory consents from local authorities; but on this occasion the matter has been fought out. The Holborn Borough Council opposed, while the St. Pancras Borough Council supported, the scheme. As a portion of Tottenham Court Road is too narrow to allow the statutory width between the rails and the kerb, the Committee refused its consent to this portion of the line, and told the promoters they would have to fix upon some spot north of this "neck" for a terminus. This decision is, in our opinion, very wise, as we believe it would be extremely foolish to add to the congestion of the traffic on such a thoroughfare by introducing tramways. When the Chief Engineer to the County Council was cross-examined regarding this absence of statutory width between kerb and rails, he ingenuously remarked that he failed to see that this was any disadvantage *to the tramway cars*. That is the Council's position in a nut-shell, as expressed by their own servant. What they appear to consider is the advantage to their tramway system, without reference to the disadvantage to ordinary vehicular traffic or to the public. We earnestly desire to see electric tramways extended widely in the country; but for London streets we cannot honestly say that they are a convenient or suitable form of locomotion.

Municipal Combination against Running Powers.

In our last issue we referred to the decision of the House of Lords Committee giving permission to the Tyneside and District Tramways Co. to run its cars over the lines of the Newcastle Corporation. The precedent thus created is a most valuable one, but it has caused something like consternation among local authorities possessing tramways. A private meeting of representatives of all the municipalities running tramways was held last month at the Westminster Palace Hotel to organise vigorous opposition to the Newcastle scheme, and a resolution was passed to the effect "That the chairmen, deputy-chairmen, and general managers of corporation tramways in all cities and boroughs in the United Kingdom viewed with great apprehension the concession made by the House of Lords Committee to a private company seeking powers to run cars over the Newcastle tramways." We readily believe that this concession is viewed by these gentlemen "with great apprehension"; but we are glad to think that Parliamentary Committees will consider the public interest of more importance than the personal feelings of a few gentlemen clothed with a little brief authority. The House of Lords Committee gave its decision after hearing evidence for and against the company's proposals, including the evidence of the Corporation's representatives, and we earnestly hope that the old familiar process of "lobbying"—practised so extensively by local authorities—may fail to induce Parliament either to upset that decision, or to refrain from following the precedent thus established. The second reading of the Tyneside Bill has, since the date of the municipal meeting, been passed by the House of Commons, and we hope the scheme may be wholly sanctioned by the time this note appears.

Progress at Newcastle-upon-Tyne.

The new issue of Preference and Ordinary Shares, by the Newcastle-upon-Tyne Electric Supply Co., Ltd., has drawn attention again to the great activity of that company, and to its happy financial position. Its record is one of which the directors may be proud, and its success is an instance of what may be achieved in electrical distribution in an industrial area by good organisation, skilful management and clear commercial insight. The following table, compiled from returns published by our contemporary, *Electrical Investments*, shows the progress made in recent years:—

Year	Units Sold	Gross Profits £	Dividend on Ordinary Shares
1898	803.789	8,140	8 per cent.
1899	967,098	9,396	8 ,,
1900	1,095.519	9,114	8 ,,
1901	2,562.383	12.564	8 ,,
1902	5.537.500	26,553	8 ,,
1903	9,033,625	44.567	8 ,,

For 1904 and 1905, the sales are estimated at 15,000,000 and 25,000,000 units respectively, and these estimates are not mere guess-work, as 80 per cent. of these amounts has already been contracted for. The rapid increase since 1900 is due to the fact, that from that year the company has been developing a power load as well as a lighting load, but the full return for the preparations and efforts made in this direction in the last three years is only now beginning to be realised. The company has among its consumers a large number of industrial firms, and also the North Eastern Railway Company, which takes power for its local electric lines, and it also gives supply in bulk to neighbouring lighting and tramway authorities. The present issue includes 17,991 Preference Shares of £5 each, and 17,991 Ordinary Shares of £5 each, the former being issued at a premium of 10s. per share, and the latter at a premium of £1 per share. Even with these premiums the shares can hardly fail to be an attractive investment.

Parcels on Tramways.

We have referred in a previous issue to the advantage that may be gained by tramway companies, by developing a system of parcel delivery over their systems. We firmly believe that there is a great opportunity here for increasing profits, besides conferring a benefit upon the public which will be much appreciated, and we are therefore glad to see that some tramway authorities have taken up the matter. The most recent results to come to our notice are those obtained by the Potteries Electric Traction Co., Ltd., on its system. In his speech at the general meeting last month, the chairman announced that the working of the parcels department in 1902, had resulted in a loss of £200; but in 1903, after allowing for depreciation of horses, vans, etc., a profit of over £300 was left. The number of parcels carried exceeded that for 1902 by 60,000, yet the working expenses of the department only increased by £43. We cordially agree with the chairman's remark, that these results show the possibility of tramway companies coping profitably with what "has been and is still a long felt want in many thickly populated districts."

* * *

GENERAL ITEMS.

Farnworth Finance.

In the published reports of the returns of the Farnworth Municipal Tramways we find this curious item: "Current (charged at ½d. per unit to relieve undertaking of loss occasioned by bad weather and poorness of trade)." If companies could do this sort of thing, automatically reducing the cost of current in poor seasons, dividends would be sure and certain; but even with this favour from the electricity department, the working expenses of the Farnworth tramways for the year amount to 9·17d. per car mile, while the receipts only reach 7·4d. per car mile. The electricity department shows a surplus of about £32.

Runcorn Provisional Order.

Another instance of a municipality transferring its lighting order to a company occurs at Runcorn, as the District Council has accepted the offer of the Mersey Electric Supply Co., Ltd., to take over the order and carry out the works. The Council is to have the option of purchasing the undertaking at the end of fourteen years on payment of the capital cost, plus 20%.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A., 78 Fleet Street, E.C.

Improvements in Switching Mechanism for Double Filament Electric Lamps.

John McCullough, Newark, United States of America. No. 26,961. Date claimed under International Convention, 10th Dec., 1902.

This invention has for its object to provide switching mechanisms actuated by a partial rotation of the lamp for controlling the circuit connections of a two filament electric lamp in which the connections with the leads are made through plates carried on the butt of the lamp, when the lamp is located in its socket, with contact posts on the latter, the locking of the lamp within its socket being effected by a bayonet joint on a partial rotation of the lamp therein. Such sockets, and single filament lamps therefor, are in common use. As an example thereof reference is made to the "Swan-Edison," and the invention is described as applied to such fixtures, although it will be understood that it may be applied to analogous constructions.

With this object in view the invention consists in means, which specifically considered, consist of a pin pivoted on one of the interlocking parts, and adapted to engage a bayonet slot in the other, whereby a bayonet joint with a range of movement over that required for the interlocking of the lamp and socket is provided, and properly disposed contact points and electrical circuits whereby such excess of movements of the two parts may be utilised for effecting changes in the circuits of the lamp, and it further consists, in the construction, arrangement and combination of the several parts of which it is composed as will be hereinafter more fully described and claimed.

Claims.—(1) In a switching mechanism for a two filament electric lamp, the combination with a lamp socket therefor, one of the said parts having slots therein, and the other having a movable member to engage the said slot, forming a bayonet joint, whereby the parts may be moved in relation to each other without releasing the bayonet joint, and contacts, connection between which is made and broken by the relative rotation of the two parts.

(2) In a switching mechanism for a two filament electric lamp, the combination with a lamp having a plurality of contacts thereon, connected to its filaments, of a pin pivoted on the butt of the lamp, and a socket having bent slots in which the pin engages, and having contact posts adapted to contact with the plates upon the lamp, according to the position of the lamp in the socket.

(3) In a two filament electric lamp the combination with the globe and filaments, of a collar surrounding the base of the lamp, contact plates upon the base connected with the filaments, and a pin projecting beyond the collar and pivoted at the centre thereof.

(4) In a two filament electric lamp, the combination with the globe and filaments, of a collar surrounding the base of the lamp and having elongated slots in its opposite sides, a pin projecting through the said slots and movable therein lengthwise of the slots, and contact plates carried by the collar and connected with the filaments.

(5) In a two filament electric lamp, the combination with the globe and filaments, of a collar surrounding the base of the lamp, having arc shaped slots in its opposite sides, a pin projecting through the said slots and movable therein, and contact plates carried by the collar and connected with the filaments.

(6) In a two filament electric lamp, the combination with the globe and filaments, of a collar surrounding the base of the lamp and having slots in its opposite sides, an insulated disc closing the

end of the collar, having radial shoulders on its inner face, a pin projecting through the said slots and centrally pivoted by the shoulders on the disc and contact plates on the disc connected with the filaments.

Electrically Operated Points and Switches for Electric Railways.

C. W. Breedlove and R. R. Grant, of Berkley, U.S.A. No. 26783. Dated 7th December, 1903.

This invention relates to new and useful improvements in electrically operated railway switches, and its object is to provide means whereby a switch tongue may be readily shifted in a desired direction by the proper manipulation of the lever of an ordinary electrical controller employed upon cars propelled by electricity.

Claims.—(1) In an electrically operated switch, the combination with a trolley wire having an insulated portion and a feed wire electrically connected to the trolley wire at opposite sides of the insulated portion, of a magnet electrically connected to the feed wire and the insulated portion of the trolley wire a contact electrically connected with the feed wire, an armature to the magnet adapted to bear upon said contact when the magnet is energised, a rotary armature, magnets therefor, a switch tongue, and means connecting said tongue and the rotary armature for transmitting motion to the tongue.

(2) In an electrically operated switch, the combination with a trolley wire having an insulated portion and a feed wire connected to the trolley wire at opposite sides of the insulated portion, of a rotary armature, magnets therefor electrically connected with the feed wire, a circuit closer within said connection and connected with the feed wire and the insulated portion of the trolley wire, an eccentric connected to and revoluble with the armature, a pitman upon the eccentric, a switch tongue, and means connecting the tongue and pitman whereby a reciprocating motion may be imparted to the tonge by the armature.

(3) In an electrically operated switch, the combination with a trolley wire having an insulated portion, of a feed wire connected to said trolley wire at opposite sides of said portion, an armature, magnets at opposite sides thereof, electrical connections between the magnets and the ground and feed wire, respectively, said armature being adapted to make a one-half revolution when the magnets are energised, an electrically operated circuit closer intermediate the feed wire and magnets and electrically connected to said feed wire and the insulated portion of the trolley wire, an eccentric connected to and revoluble with the armature, a pitman mouuted thereon, and a switch tongue connected to and adapted to be operated by the pitman.

(4) In an electrically operated switch, the combination with a trolley wire, having an insulated portion and a feed wire connected to the trolley wire at opposite sides of said insulated portion, of a circuit closer connected to the feed wire and the insulated portion, a commutator, means for simultaneously rotating said commutator and closing the circuit, alternately arranged overlapping conducting plates upon the commutator, a brush for all of said plates adapted to be electrically connected to the feed wire by the circuit closer, a rotary armature adapted to be partially rotated in either direction, a switch tongue connected to and operated thereby, and means for conducting a current through the commutator to either side of the armature.

(5) In an electrically operated switch, the combination with a switch tongue, of a rotary armature having coils at right angles to each other and adapted to partially rotate, means connecting the armature and tongue whereby the tongue may be shifted by said armature, magnets to the armature, a commutator, a trolley wire having an insulated portion, a feed wire connected to the trolly wire at opposite sides of the insulated portion, an electrical connection between the feed wire and commutator, a circuit closer within said connection connected with the feed wire and the insulated portion, and means operated by the circuit closer for rotating the commutator whereby a current may be directed into either coil of the armature.

(6) In an electrically operated switch, the combination with a trolley wire having an insulated portion and a feed wire connected to the trolley wire at opposite sides of said portion, of a magnet electrically connected with the feed wire and the insulated portion, an armature to the magnet, a contact electrically connected to the feed wire, a plug connected to the armature adapted to bear upon the contact, a rotary shaft, a commutator thereon, a ratchet wheel revoluble with the commutator, and a pawl connected to the armature and engaging the ratchet wheel.

(7) In an electrically operated switch, the combination with a trolley wire having an insulated portion and a feed wire connected to the trolley wire at opposite sides of said insulated portion, of a magnet electrically connected to the feed wire and the insulated portion, an armature, a shaft, a commutator secured to and revoluble with the shaft and having oppositely extending overlapping conducter plates in the periphery thereof, a ratchet wheel revoluble with the commutator, and a pawl connected to the armature and engaging the ratchet wheel.

(8) In an electrically operated switch, the combination with magnets and a rotary armature there between having coils at right angles to each other, of commutators revoluble with said armature, electrical connections between one of the commutators and both coils, electrical connections between said coils and the other commutator respectively, a feed wire, and electrically operated means for directing a current from the feed wire to either coil of the armature.

Readers are referred to the World's Electrical Literature of the month as detailed on pages 554 to 557. Particulars are there given of the contents of the World's Electrical Press, and of papers read before Scientific Societies. If there are any articles or papers in the list which any reader wishes to procure, we will forward the same with a minimum of delay at but small cost. This section is one of the most valuable of "The Electrical Magazine."

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers are given.

Radium und andere radioaktive Substanzen.

(Radium and other radioactive substances).

By E. Ruhmer. 1904. F. & M. Harrwitz, Berlin. Price M.2.50.

This is a translation, with numerous additions, including a valuable bibliography of the subject of radioactivity, of a lecture by W. J. Hammer at the joint meeting in April, 1903, of the American Institute of Electrical Engineers, and the American Electrochemical Society.

A. B. C. of the Telephone.

By J. E. Homans. Theo Andel & Co., 63 Fifth Avenue, New York. 1904. Price 4s. post free.

In addition to a number of new features this revised American treatise contains a stock of information which all beginners in telephone work should acquire. The theory of sound, history of the telephone, brief principles of electricity, electrical quantities, intercommunication and common battery systems, together with wireless telephony, are a few of the subjects dealt with. The numerous diagrams and illustrations enable the worded description of the subjects to be followed with ease. After mastering all the information contained in the book, the student will have gained an elementary knowledge which can be extended by practical experience and further study of a more advanced treatise.

Construktion und Prüfung der Elektricitätszähler.

Von A. Königswerther. Gebrüder Jänecke, Hannover. M.9.

Until quite recently, the literature of electric meters may have been said to be non-existent. This want is gradually being supplied, and among continental books on the subject that under review is one of the most comprehensive and important.

The work is divided into three parts. Part I. deals with the theoretical basis of the subject, and the author is to be congratulated on his concise and lucid method of treatment. Part II., which forms the bulk of the book, deals with the practical construction of electric meters. Most of the forms described are, as is only to be expected, Continental types, although a fair number of English and American meters also receive detailed treatment. Special sections are devoted to meters for use with secondary batteries, to portable and electric railway meters, to maximum demand indicators, to pre-payment meters, and to transformers used for measuring purposes. Part III. deals with meter testing, and in this connection the detailed accounts of the meter-testing departments at Munich and at the Physikalisch-Technische Reichsanstalt are most interesting. The book is profusely illustrated, and although the line and sectional drawings are very good, the reproductions from photographs leave a good deal to be desired.

Moderne Gesichtspunkte für den Entwurf Elektrischer Maschinen und Apparate.

(Modern Views regarding the Design of Electrical Machinery and Apparatus).

By Dr. F. Niethammer. R. Oldenburg, Munich and Berlin. 1903. M.8.

All who are anxious to keep pace with recent developments in electrical design will find this book most interesting and instructive reading. The author, whose wide practical experience (acquired while he acted as chief engineer to the Union Company of Berlin) and high scientific attainments place him in the front rank of leading electrical engineers of the day, speaks with the weight of exceptional authority on the subjects with which he deals. Some of the matters discussed have already appeared in a leading periodical, but the present volume is a systematic account of the trend of modern design, and as such it is worthy of the closest study. In the space at our disposal, we can do little more than briefly indicate the contents and general scope of the book. The usual types of generators are dismissed very briefly, but those designed for either very low or very high speeds receive more detailed treatment. The problems relating to the efficiency as conditioned by the various losses, to the maximum rise of temperature and methods of ventilation, to the safe limits of voltage and the insulation of continuous and alternating current generators and to the regulation of the terminal p.d., are fully discussed. Then follow separate sections devoted to continuous-current machines, rotary converters, polyphase generators and motors, single-phase motors and transformers. The remaining sections deal with various forms of motor-starters, electric brakes and magnetic clutches, contact-shoes for electric cars and locomotives, switchboards and switch-gear. The book is copiously illustrated, and most of the illustrations are very good; though some of those reproduced from photographs are rather poor. We can strongly recommend the book to all electrical engineers who can read German.

The Law relating to the Telegraph, the Telephone, and the Submarine Cable.

By Evelyn G. M. Carmichael, M.A., of the Inner Temple and Oxford Circuit, Barrister-at-Law; author of "The County and Borough Police Acts." 1904. London: Knight & Co. Price 10/6 net.

This book contains the text of all the statutes relating to telegraphs, telephones, and submarine cables, with notes by the author on the important sections. There is also an introduction giving (1) a short historical sketch of the development of telegraphy and telephony and the consequent legislation to deal with the new means of communication ; and (2) brief notes on various common law problems in which telegraphic messages play a part. In a work of this kind the author's notes are, of course, the most important matter, as the rest is merely compilation; and in the present case care seems to have been taken to make these as useful as possible to the reader. All the principal cases dealing with the interpretation of sections, or throwing light upon them, are mentioned, and the effect of the decisions explained, and such questions as nuisance, rating of telegraphs, etc., are also considered. In addition to the Telegraph Acts, the Post Office Acts, and the Submarine Telegraph Acts, the volume contains the London Overhead Wires Act, 1891; the London County Council's Subways Act, 1893; and parts of the Public Health Acts Amendment Act, 1890. All of these statutes contain provisions regarding telegraph wires and the rights of the Postmaster-General and are properly included in a work which is intended to be "a complete text-book of the law" relating to the subject described in the title. As an exposition of the law on an important branch of practical electricity, the volume is welcome.

The Steam Turbine.

By R. M. Neilson. 2nd Edition, revised and enlarged. Longmans, Green & Co. 39 Paternoster Row, London. Price 10s. 6d. nett.

A modern engineer's library nowadays would not be complete without some literature on the steam turbine, and the first actual text book on the subject must have supplied a long felt want. The author appreciates the rapid advancement that is being made in this field, and the second edition so soon after the appearance of the original is well up-to-date. The book starts with a chapter on the general principle of steam turbines, and then proceeds with the history of the various types, which will be found interesting from the fact that all present forms seem to be more or less modifications of what was originally invented by our forefathers. An interesting chapter is devoted to the subject of vanes and velocities, while, in the succeeding two chapters, the entropy temperature diagram, in connection with the steam turbine, is carefully gone into.

The general design of the Parsons, the De Laval, and the Ratteau turbines is pretty fully illustrated, though it may be said the information given is of a general character; little can be learned of the details of construction.

Brief descriptions are given of the Westinghouse, Stumpf, Seger, Schulz, and the Curtis Turbines.

An interesting table shows the approximate floor space required for various types of prime movers, and the concluding chapter deals with the propulsion of vessels by turbine machinery.

The book as a whole, is well illustrated and will prove an interesting volume to those generally interested in steam turbine work, but as a text book, it lacks in detail description, which can be understood when so little of this information is so far in the possession of those other than the actual designers of steam turbine machinery.

Electricity and Magnetism.

By C. E. Ashford, M.A. Edward Arnold, London. Price 2s. 9d.

In its essential features, this is an up-to-date and reliable elementary text-book, and the arrangement of the subject-matter is one well calculated to make the learner think for himself. The main blemishes which have attracted our attention are the following: On p. 102 it is stated that "the electrostatic unit of quantity represents an amount of electricity 3×10^{10} times as large as the electromagnetic absolute unit," whereas, of course, the converse is true. The treatment of Ohm's Law in chapter IX. is a good example of the highly pernicious method of dealing with this important subject which is characteristic of dozens of elementary text-books. Lastly, the diagrams of the magnetic field of a two-pole dynamo given on pp. 158 and 159 are hopelessly wrong.

Electric and Magnetic Circuits.

By Ellis H. Crapper, M.I.E.E. Edward Arnold, London. Price 10s. 6d.

This book should prove extremely useful to both teachers and students of electrical engineering. The general plan adopted by the author consists in enunciating certain general principles, and then illustrating them by a copious supply of examples. For the student who has to dispense with the aid of a teacher this arrangement is an ideal one, and in other cases it has the merit of saving a considerable amount of time to both student and teacher. We have noticed comparatively few inaccuracies, the more important of which may be pointed out. On p. 3, it is stated that "the ampere may be defined as the time rate of change of the coulomb per second"; but surely the coulomb, a constant quantity chosen as a unit, is incapable of changing or having a rate of change. For the above, we therefore suggest "the ampere may be defined as the time rate of change of electric quantity, the quantity being expressed in coulombs." The diagram on p. 157 of the field surrounding a magnet is wrong, the refraction of the lines not being indicated. Lastly, on p. 296, we read the rather staggering statement "by expressing these quantities of *energy* in *watts*," with the same error repeated on p. 297, although earlier in the book the author clearly explains the difference between *energy* and *power*.

Electricity and Magnetism.

By R. T. Glazebrook, M.A., F.R.S. Cambridge: at the University Press. Price 7s. 6d.

In this elementary text-book, experimental investigation and mathematical treatment go hand-in-hand, and the student is thus not allowed to lose sight of the close connection between the two. There can, of course, be no scope for originality in a book of this kind, as probably every possible arrangement of the subject-matter, and every possible mode of treatment, have been embodied in the extremely numerous text-books already in existence. That the book is essentially modern will be evident from the fact that the concluding chapter deals with such subjects as the discharge of electricity through gases, cathode rays, electrons and the electron theory of matter.

Modern Electric Practice.

Editor Prof. Magnus Maclean, M.A., D.Sc. Vol. II. London: The Gresham Publishing Co. Price 9s.

Having formed a very high opinion of this work from a study of Vol. I., which was reviewed in the March number of this Magazine, we naturally looked forward with great interest to the succeeding volumes. We have now before us Vol. II. of the series, and we are bound to admit that this fully maintains the high standard of excellence set by the previous volume.

The subjects dealt with in Vol. II. are alternating current motors, static transformers and rotary converters, electric storage batteries, switches and switch gear, and electric mains. As in the previous volume each of these sections is written by an expert in that particular subject. After a few introductory remarks, the fundamental principles of alternating current motors are considered in chap. I. Following this is a well written section on the principles of construction and operation of single phase, two phase, and three phase synchronous motors; the advantages and disadvantages of synchronous and asynchronous motors respectively, and the construction of asynchronous or induction motors. Chap. III. contains a very interesting discussion of the theory of alternating current motors treated graphically by means of vector diagrams. Six chapters in section 7 are devoted to static transformers and rotary converters. The part dealing with the testing of transformers is rather brief and might with advantage be extended. Section 8 treats very fully of electric storage batteries in two chapters devoted respectively to stationary and portable cells. These chapters will be found to contain a great deal of very valuable information on almost all the successful types of secondary batteries in use. The results of many practical tests of these cells are given, thus enabling comparisons to be made of the suitability for various purposes of different types of cell. The conditions that have to be fulfilled by portable cells are clearly set out, and the influence these have on the design of the cells indicated. This is a subject of very great importance at the present time in view of the application of storage cells to the propulsion of road vehicles. This section is well up to date and includes a description of the new Edison cell, although the results of the latest tests on it have not been given.

The opening chapter of the part indexed electric lighting and power distribution is concerned with switches and switch gear, ordinary switches for consumers being taken first. The proper lines along which the design of these important parts of an electric installation should be carried out are clearly indicated, and illustrated descriptions of all the usual forms, from "tumbler" switches to motor starting switches, will be found. Central station switch gear is next very fully treated, both low tension direct current and high tension alternating current switch gear being described and illustrated by many figures and diagrams.

Electric mains are dealt with in seven short chapters at the end of the book, in which dielectrics, systems of underground mains, earthing and bonding, fusing, balancing, fault localising, and joints and jointing are all discussed. These chapters might all with advantage have been extended, and some information regarding the relative costs of laying and maintaining the various systems would have been a valuable addition.

The book is excellently got up, the type is large and clear, and the diagrams are clear and distinct.

Die Galvanoplastik.

(Electrotyping.)

By Dr. W. Pfanhauser. W. Knapp, Halle. Price 4 marks.

This is an excellent and thoroughly up-to-date monograph on the subject of which it treats. After giving a brief historical sketch and a list of the more important treatises on the art of electrotyping, the author proceeds to explain the preliminary processes connected with it—the production of moulds in metal, wax-like substances, lime and plaster-of-paris. The various methods for rendering the surface of the mould conducting are next explained. The composition and preparation of the plating baths for copper, nickel, steel, gold and silver, are then fully considered. In the next section, the author deals with the various irregularities and difficulties which arise in electrotyping. The material and construction of the anodes, and the modes of current generation, form the subjects of the next two sections, while the concluding section deals in detail with the various applications of electrotyping. Some useful tables are given at the end of the book, including thermo-chemical data, electro-chemical equivalents, atomic weights, wire tables, resistivities of electrolytes, etc. A word of praise is due to the publishers for the general excellence of the "get-up" of the book.

BOOKS RECEIVED.

Oil Engines. W. A. Tookey. Merritt & Hatcher, Ltd. Grocers' Hall Ct., Poultry, E.C. 1s. nett.

Workshop Costs. S. & F. Pearn. Technical Publishing Co., Deansgate, Manchester. 21s. nett.

X Rays Simply Explained. R. P. Howgrave-Graham, A.I.E.E. Percival Marshall & Co., 26-29 Poppin's Ct., Fleet St., E.C. 6d. nett.

Entropy. James Swinburne. A. Constable & Co., 2 Whitehall Gdns., S.W. 4s. 6d. nett.

Practical Electro-Chemistry. Bertram Blount. A. Constable & Co. 15s. nett.

Dynamo, Motor, and Switchboard Circuits. W. R. Bowker. Crosby Lockwood & Son, 7 Stationers' Hall Ct., E.C. 6s. nett.

Notes on Alternate Currents for Students. H. H. Simmons. Cassell & Co., La Belle Sauvage, Ludgate Hill. 1s. 6d. nett.

The Electrical Industry. A. Gowans Whyte. Methuen & Co., 36 Essex St., W.C. 2s. 6d. nett.

National Progress in Wealth and Trade. A. L. Bowley. P. S. King & Son, Orchard House, Westminster. 2s. nett.

Elementare Vorlesungen über Telegraphie und Telephonie. Parts I. to VI. Dr. R. Heilbrun. Georg Siemens, Berlin. 1.60 each part.

Modern Wiring Diagrams and Descriptions for Electrical Workers. H. C. Horstmann & V. H. Fowley. F. J. Drake & Co., Madison St., Chicago.

Handy Electrical Dictionary; and ***Swingle's 20th Century Handbook for Steam Engineers and Electricians.*** F. J. Drake & Co., Chicago.

Dynamo Attendants and Their Dynamos. F. Broadbent, M.I.E.E. S. Rentell & Co., Ltd., 36 Maiden Lane, W.C.

Electric Lighting Accounts. G. Johnson. Gee & Co., 34 Moorgate St., E.C. 5s. nett.

A First Book of Electricity and Magnetism. W. Perren Maycock, M.I.E.E. Whittaker & Co. 2s. 6d. nett.

Technological and Scientific Dictionary. Part I. Edited by G. F. Goodchild and C. F. Tweney. G. Newnes, Ltd. 1s. nett.

Modern Engines and Power Generators. Vol. II. Rankin Kennedy, C.E. Caxton Publishing Co., Chancery Lane. 9s.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whole will form an index guide of considerable importance and value.

❦

Power.

Articles.

Distribution. Return by the Earth.	*Rev. Indus.* 12/3/04.
*Hydro-Electric Station of Champ. E. Bignami.	*Elec. Rev. N.Y.* 9/4/04
Steam Turbine at Port Huron Power Station. J. E. Davidson.	*Elec. Wld. & Eng.* 9/4/04.
The Paris Est-Lumière Co.'s Distributing System and Plant.	*L'Eclair Elect.* 9/4/04.
A Long Distance Transmission Line. B. Wiley.	*Elec. Wld. & Eng.* 16/4/04.
100 Ton Double Trolley A.C. Crane. W. W. Briggs.	*Elec. Wld. & Eng.* 23/4/04.
*The Prevention of Crosses between Signalling and High Voltage Circuits. H. S. Knowlton.	*Elec. Wld. & Eng.* 23/4/04.
Electric Distribution to Small Factories at St. Mortier, France. F. Koster.	*Elec. Wld. & Eng.* 23/4/04.
Horse-power of Steam Engines. T. A. Taylor.	*Elec. Wld. & Eng.* 23/4/04.
Power Plant on the Avancon River, Switzerland. F. Koester.	*Westn. Elec.* 23/4/04.
A New Canadian Gas and Electric Station. F. C. Perkins.	*Westn. Elec.* 23/4/04.
Agricultural Electricity. E. Guarini.	*Rev. Tech.* 25/3/04.
Law Concerning Hydraulic Powerhouses.	*L'Ind. Elec.* 25/4/04.
The Application of Electricity to Winding Engines. Larmoyer.	*Bul. de l'Inst. Montef.* 25/4/04.
Calculation of Conducting Poles for Electric Lighting and Power Plants. G. Sattler.	*Helios* 27/4/04, 4/5/04.
*Selection of Transmission Circuits. A. D. Adams.	*Street Rly. Rev.* *April*, /04.
Necessity for Lightning Arresters in Villages. Kirstein.	*Elek. Anzr*, 28/4/04.
Power Station, New Richmond Roller Mills. R. D. Thomas.	*Elec. Rev. N.Y.* 30/4/04.
Water Power Plant, Elliott's Falls, Ontario. C. L Fitch.	*Canadian Elec. News.* *April*, /04.
The Overhead Plant of the Hanover Tramways. L. Liebenberg.	*Elek. Zeit.* 3/5/04.
The Central Electric Supply Co.'s Power Station	*Elec. Rev* 6/5/04
Electric Governor for Steam Turbines. G. Dary.	*L'Elec.* 7/5/04.
Electricity in Agriculture. Guarini.	*L'Elec.* 7/5/04.

Papers before Societies.

High and Moderate Voltage Lines. (Discus.)	*Amer. Inst E.E.* *(Chicago)*. 26/4/04.
*Power Station Design. C. H. Merz. and W. McLellan.	*Inst.E.E.* 28/4/04.
Controlling and Safety of Electric Plants. F. Tischendörfer.	*Assoc. Consult. Elec. Eng., Berlin* 5/5/04.
*The Steam Turbine as Applied to Electrical Engineering. C. A. Parsons, G. G. Stoney, C. P. Martin.	*Inst.E.E.* 12/5/04.
Motor Starting Switches and Resistances. T. O. Hunt.	*Birhm. Inst.E.E.* 18/5/04.
Electric Power in Textile Processes. T. A. Carver.	*Brit. Assoc. Mangrs. Textile Works.*

Traction and Transport.

Articles.

Electric Traction with Alternate Currents.	*L'Elec.* 26/3/04.
Palermo Tramways. E. Guarini.	*Electro. March*, /04.
Automatic Electric Points.	*R. Gén. des Ch. de Fer. March*, /04.
Sahulka Electro-pneumatic Railway.	*Westn. Elec.* 2/4/04.
Determination of the Insulation of the Supports of the Third Rail. Pillier.	*L'Elec.* 9/4/04.
Copenhagen Tramways. S. Velander.	*Tek. Tids.* 9/4/04.
Round the Intra-Mural. F. L. Merrick.	*Elec. Rev. N.Y.* 9/4/04.
Notes on Electric Railways in North Italy. Koromzay.	*L'Eclair Elect.* 9/4/04.
The Fayet-Chamonix Electric Railway. S. Hertzog.	*Elek. Zeit.* 9, 23/4/04.
Electric Braking of Railways and Tramways. J. Bethenod.	*Elek. Zeit.* 9, 23/4/04.
Resistance with Alternating Current in Railway Operation. A. Enström.	*Tek. Tids.* 9/4/04.
Some Details of the Westinghouse Single-phase Railway System. W. P. Maycock.	*Elec. Rev.* 15/4/04.
*Developments in Heavy Electric Traction. C. L. de Muralt.	*Railrd. Gazette.* 15/4/04.
*Engaging Men on the Boston Elevated Railway.	*Street Rly. Jrnl.* 16/4/04.
Operating Features of the Los Angeles Railway Co.	*Street Rly. Jrnl.* 16/4/04.
*Fall of Alternating Currents in Railway Rails. Dr. H. Behn-Eschenburg.	*Elek. Zeit.* 21/4/04.
All Electric Interlocking at Park Junction.	*Rlrd. Gazette.* 22/4/04.

*A New System of Current Collecting for Heavy Electric Traction Lines. H. Somach.	*Street Rly. Jrnl.* 23/4/04.
Adjusting Car Resistances. C. Gough.	*Street Rly. Jrnl.* 23/4/04.
*Disposal of City Ashes as an Adjunct of Street Railway Business in Brooklyn.	*Street Rly. Jrnl.* 23/4/04.
Dock Street Sub-station, Schenectady Railway Co.	*Elec. Rev. N.Y.* 23/4/04.
The Bouches-du-Rhône Electric Tramways Plant. A. Z.	*L'Ind. Elec.* 25/4/04.
Single-Phase Alternating Current Railways. F. C. Perkins.	*Elec. N.Y.* 27/4/04.
*The Continuous Current System and the Single-phase System for Traction. H. M. Hobart (concld. 6/5/04.)	*Elec. Rev.* 29/4/04.
Means of Transport in Berlin and Paris. Jacquin.	*Rev. Elec.* 30/3/04.
*The Los Angeles and Redondo Railway.	*Street Rly. Jrnl.* 30/4/04.
North Dakota Electric Railway.	*Street Rly. Jrnl.* 30/4/04.
Means of Transport in Hamburg and Kiel. Jacquin.	*La Rev. Tec.* 30/4/04.
Trent Valley, Canada. J. A. Culverwell.	*Canadian Elec. News. April,* /04.
Electrical Equipment for Cornwall Canal. F. H. Leonard, jun.	*Canadian Elec. News. April,* /04.
Traction Tests with Monophase.	*La R. des Ch. de Fer. April,* /04.
Tramway and Railway Joints.	*Try. & Rly. Wld. April,* /04.
*The Tramway System of Manchester. II.	*Try. & Rly. Wld. April,* /04.
*Hiring, Training, and Handling Employees in Electric Railway Work. C. H. Cox.	*Street Rly. Rev. April,* /04.
Devices for Protecting Overhead Tramway Lines from the Fall of Telephonic and other Conductors. De K.	*L'Elec.* 7/5/04.

Lighting and Heating.

Articles.

Mercury Lamps. Conductivity of Mercury Vapours.	*L'Elec.* 12/3/04.
A Comparison of Different Luminous Sources. Fansler.	*L'Elec.* 26/3/04.
On the Regulation of the Resistance of Mercury Vapour Lamps.	*L'Elec* 2/4/04.
The Repartition of Light. Georges Dary.	*L'Elec.* 9/4/04.
Current Consumption in Electrical Lighting Plants. Th. Vaillant.	*Elek. Ansr.* 10/4/04.
A Contribution to the Theory of Differential Arc Lamps. W. B. v. Czudnochowski.	*Phys. Zeit.* 15/4/04.
Differential Arc Lamp with Recoil Movement. Aliamet.	*L'Elec.* 16/4/04.
Luminous Electric Signboards. G. D.	*L'Elec.* 16/4/04.
White Star Steamer "Baltic's" Electrical Equipment. G. E. Walsh.	*Elec. Rev. N.Y.* 16/4/04.
Electric Installations on Board Warships. Serial. Leblond.	*L'Ind. Elec.* 25/4/04.

Telegraphy and Telephony.

Articles.

On a Theory of Wireless Telegraphy, Hettinger.	*Rev. Elec.* 26/3/04.
A New Method for Connecting Apparatus on Telegraphic and Telephonic Lines. Banti.	*Rev. Elec.* 30/3/04.
Progress in Wireless Telegraphy.	*Gén. Civ.* 2/4/04.
Resonance Induction Coils and their use in Wireless Telegraphy. Dr. G. Seibt.	*Elek. Zeit.* 7/4/04.
An Improvement in Rapid Telegraphy. De Grandmisson.	*L'Elec.* 9/4/04.
*A Unique Cordless Switchboard.	*Amer. Telep. Jrnl.* 9/4/04.
The Berlin Teletyping Central Station. A. Gradenwitz.	*Elec. Rev. N.Y.* 9/4/04.
The Telephone Sub-station. III. A. V. Abbott.	*Elec. Wld. & Eng.* 9/4/04.
*Telephone Engineering. I. J. C. Kelsey.	*Elec. Rev. N.Y.* 9/4/04.
Methods for Increasing the Transmitter Energy in Wireless Telegraphy. F. Braun.	*Phys. Zeit.* 15 4/04.
Points on Electricity (contd.). W. H. Jones.	*Teleg. Age.* 16/4/04.
Telegraphy in Siberia. L. Lodian.	*Elec. Rev. N.Y.* 16/4/04.
*Telephone Engineering. II. J. C. Kelsey.	*Elec. Rev. N.Y.* 16/4/04.
*Telephone Exchange Engineering. XVII. Multiple Cable. R. H. Manson, A. D. T. Libby, C. A. Simpson.	*Amer. Telep. Jrnl.* 16/4/04.
*Recent Experiments in Wireless Telephony. A. Gradenwitz.	*Amer. Telep. Jrnl.* 16/4/04.
Auxiliary Telephone Circuits. C. H. Coar.	*Amer. Telep. Jrnl.* 16/4/04.
Electric Transmission of Photographs, etc., System Korn. G. Will.	*Elek. Ansr.* 21/4/04.
Increasing the Transmitter Energy of Wireless Telegraph Systems. F. Braun.	*Electn.* 22/4/04.
A Unique Telephonic Catastrophe. E. Hutton.	*Amer. Telep. Jrnl.* 23/4/04.
Telephone Engineering. III. J. C. Kelsey.	*Elec. Rev. N.Y.* 23/4/04
Wireless Telephony by Selenium Cells. A. Gradenwitz.	*La Rev. Tec.* 25/4/04.
Wireless Telegraphy (contd.). R. G. Blaine.	*Elec. Eng.* 29/4/04.
*The Telephone Scout. G. E. Frost.	*Amer. Telep. Jrnl.* 30/4/04.
Impedance and Retardation. A. V. Abbott.	*Amer. Telep. Jrnl.* 30/4/04.
Keeping Exchange Records. R. Bayley.	*Amer. Telep. Jrnl.* 30/4/04.
The Plant of the Kansas City Home Telephone Co. M. Lœwenthal.	*Elec. Wld. & Eng.* 30/4/04.
Transformers for Telegraph Plants. M. Glück.	*Elek. Ansr* 1/5 04.

Electro-Chemistry.

Articles.

Polarisation of Gold and Palladium Electrodes. Rothé.	*Ann. de Ph. et de Ch. March,* /04.
The Rectifying of Tri-phase Currents by Electrolytic Valves. Mors.	*L'Ind. Elec.* 25/3/04.
The Decomposition of Anodes. Serial (contd. 2, 9, 16/4/04). Jouve.	*L'Elec* 26 3/04.
Theory of Ions and Electrons (contd. 9/4/04). Berthier.	*Gén. Civ.* 2/4/04.
On a Process for the Rapid Formation of Accumulators. Lejeune.	*L'Elec* 9/4/04.
Influence of Light on Speed of Formation of Accumulator Plates. G. Rosset.	*Centr. für Accum.* 15/4 04.
Method for the Determination of Mutual Induction Coefficients. Montpellier.	*L'Elec.* 16/4/04.
Hydraulic Analogy of the Aluminium Electrolytic Condenser. C. I. Zimmerman.	*Elec. Rev. N.Y.* 30/4/04.

Bell Process for Electrolysis of Acqueous Solutions of Alkali Chlorides. Dr. O. Steiner.	*Zeit. für Elek.* 6/5/04.

Papers.

Influence of the Physical Nature of the Anode on the Constitution of Electrolytic Peroxide of Iron. Hollard.	*Sté. Ch. Paris.* 5/3/04.
On the Electrolytic Dissolution of Platinum. New Process for the Preparation of Platino-cyanide. Brochet et Petit.	*C. Rendus de l'Acad. des Scs. Paris.* 2/5/04.
On the Origin of Blondlot Rays Evolved during Chemical Reaction. Becquerel.	*C. Rendus de l'Acad. des Scs. Paris.* 2/5/04.
The Electrolytic Oxidation of Anthracine. A. Fontana and F. M. Perkin.	*Faraday Soc.* 9/5/04.
Electro-chemical Reductions. Prof. Elbs.	*German Soc. Elec. Chem.* 12-14/5/04.

Electro-Physics.

Articles.

Equivalent Values of Self-induction and Capacity in Parallel.	*L'Ind. Elec.* 10/3/04.
"Magneta" Clocks. Hospitalier.	*L'Ind. Elec.* 25/3/04.
Radio-activity of Becquerel Matter.	*L'Eclair Elect.* 2/4 04.
Calculating Self Induction Coefficients and Capacities. A. König.	*Elek. Anzr.* 10, 14/4/04.
Ionisation of Air. J. Don.	*Elec. Rev.* 15/4/04.
Standard Element for Technical Laboratory. G. Rosset.	*Centr. für Accum.* 15/4/04, 1/5/04.
On Radioactive Emanation from Water and Oil. F. Himstedt.	*Phys. Zeit.* 15/4/04.
The Spectrum of Radium Emanation. Th. Indrikson.	*Phys. Zeit.* 15/4/04.
Electrical Field in the Interior of Insulators Immersed in Electrolytes. W. Von Nicolajew.	*Phys. Zeit.* 15/4/04.
Streamers or Side Discharges from Electrodes. A. G. Dell.	*Elec. Wld. & Eng.* 16/4/04.
The Theory of Radio Activity. F. J. Hillig.	*Westn. Elec.* 23/4/04.
Steatite Suspension Fibres for High Precision Instruments.	*L'Ind. Elec.* 25/4/04.
The Block Element. Vollschwitz.	*Helios* 27/4/04.
The Measurement of Electrical Conductivity. J. Rymer-Jones.	*Elec. Rev.* 29/4/04.
Influence of Temperature on Electric Conductivity of Sodium. A. Bernini.	*Phys. Zeit.* 1/5/04.
*Improved Form of Zinc Sphere Photometer. J. Elster and Geitel.	*Phys. Zeit.* 1/5/04.
Electric Flux in Flames between neighbouring Electrodes. F. L. Tufts and J. Stark.	*Phys. Zeit.* 1/5/04.
On the Realisation of a High Tension Electrostatic Field. Guye and Denso.	*L'Eclair Elec.* 7/5/04.
Starting and Change-gear Devices for Electromotors. Reyval.	*L'Eclair Elec.* 7/5/04.
Measurement of Energy in Electric Current Impulses. H. Weichsel.	*Zeit. für Elek.* 8/5/04.

Papers.

Argon. Electric Cohesion.	*L'Acad. des Scs. Paris.* 7/3/04.
Electrogoniometer by M. M. Grammont and Routin.	*L'Acad. des Scs. Paris. March,* /04.
Further Experiments of the Production of Helium from Radium. Sir Wm. Ramsay and F. Soddy.	*Royal Soc.* 28/4/04.
Sparking Distance between Electrically Charged Surfaces. P. E. Shaw.	*Royal Soc.* 28/4/04.
An Apparatus for Testing High Speed Motors. Renard.	*C. Rendus de l'Acad. des Scs. Paris.* 2/5/04.
Three Years' X Rays Work. L. H. Harris.	*Röntgen Soc.* 5/5/04.
The Röntgen Society: Its Past Work and Future Prospects. J. J. Vizey.	*Röntgen Soc.* 5/5/04.
Some Experiments with Alpha Rays. F. H. Glew.	
Instruments for the Measurement of Large and Small Alternating Currents. W. Duddell.	*Phys. Soc.* 6/5/04.

Electro-Metallurgy.

Articles.

Electric Welding. H. Hellberger.	*Elek. Zeit.* 9, 23/4/04.
Electric Induction Current Furnaces.	*Jrnl. de L'Electrol.* 1/5/04.
Electric Furnace for Winning Metals from their Ores.	*Jrnl. de L'Electrol.* 1/5/04.
Crystallised Zirkoniums in Electric Furnaces. E. Wedekind.	*Zeit. für Elek.* 6/5/04.

Paper.

The Ruthenberg Electrical Concentration and Reduction Process. H. Goldschmidt.	*German Soc. Elec. Chem.* 12-14/5/04.

Students.

Articles.

*Alternate Current Working. I. W. B. Gump.	*Westn. Elec.* 9/4/04.
Technical Education: London and Birmingham. C. A. Smith.	*Elec. Rev.* 22/4/04.
*The Elementary Principles of Transformer Design. I. Prof. T. Gray. (II. 30/4/04.)	*Elec. Wld. & Eng.* 23/4/04.
*Alternate Current Working. II. W. B. Gump.	*Westn. Elec.* 23/4/04.

Papers.

Insulation and Insulators. H. D. Symons.	*Inst.E.E. (Stdnts.).* 27/4/04.
Equipment and Maintenance of Electric Street Cars. C. W. Crosbie.	*Manch. Inst.E.E. (Stdnts.)* 29/4/04.
Alternating Current Commutator Motors. F. Creedy.	*Inst.E.E. (Stdnts.)* 4/5/04.

Manufacturers.

Articles.

Armature Reaction in Alternators. Guilbert.	*Rev. Tech.* 25/3/04.
Electric Equipment of Tool Machinery. Guarini.	*L'Eclair Elect.* 26/3/04.
The "Monarch" Electro Automatic Safety Apparatus. G. Dary.	*L'Elec.* 2/4/04.
Notes on Mining Plant (contd. 9/4/04). Guarini.	*L'Eclair Elect.* 2/4/04.
The Brown Boveri Parsons Steam Turbine. E. Scherenberg.	*Elek. Zeit.* 9/4/04.
Combined Induction and Repulsion Motor. C. F. Holmboe.	*Tek. Tids.* 9/4/04.
*The Louisiana Purchase Exposition (detailed account).	*Westn. Elec.* 16/4/04.
*The Efficiency Curves of Constant Potential Transformers. A. E. Kennelly.	*Elec. Wld. & Eng.* 16/4/04.
Combined Punching Machine and Slitting Rolls. W. H. Eisenbeis.	*Amer. Mach.* 16/4/04.
Design of Continuous Current Motors for Variable Speed. F. Punga.	*Elec. Rev.* 22/4/04.
*The Experimental Pre-determination of the Regulation of Alternators. T. Torda-Heymann.	*Electn.* 22/4/04.
A New Push-button Voltmeter Switch. C. L. Fitch.	*Elec. Wld. & Eng.* 23/4/04.
Alternator Diagrams. Guilbert.	*La Rev. Tec.* 25/4/04.

Modern Hydraulic Turbine Construction. Hanssens.	*Bul. de l'Inst. Montef.* 25/4/04.
On Polyphase Commutator Machines. (Heyland and Latour.) Ham.	*Bul. de l'Inst Montef.* 25/4/04.
The Fundamental Equations for Variable Currents in Parallel Circuits. Willame.	*Bul. de l'Inst. Montef.* 25/4/04.
*Asbestos and its Uses.	*Elec. Rev.* 29/4/04.
Mica and its Applications. J. C. B.	*Elec. Eng.* 29/4/04.
Continuous Current Transformers. J. W. Burleigh.	*Elec. Eng.* 29/4/04.
Types of Direct Current L.T. Switchgears. III. W. E. Warrilow.	*Elec. Eng.* 29/4/04.
*The Design of Induction Motors, with Examples from Recent European Practice. H. M. Hobart.	*Elec. Wld. & Eng.* 30/4/04.
A Test for Induction Motor Windings. G. H. Gardlon.	*Elec. Club Jrnl. April, /04.*
Carriage for Transporting Motor Armatures.	*Gén, Civ.* 7/5/04.
The Situation of Electro-technical Industry at Berlin in 1903. A. Giron.	*L'Elec.* 7/5/04.
Single-Phase Commutator Motor. K. Sumec.	*Zeit. für Elek.* 8/5/04.

Papers.

*The Commercial Side of Engineering. A. Herbert.	*Coventry Eng. Soc.* 22/4/04.
*The Mechanical Construction of Revolving Field Alternators. D. B. Rushmore.	*Amer. Inst.E.E.* 22/4/04.
*Contribution to the Theory of the Regulation of Alternators. H. M. Hobart, F. Punga.	*Amer. Inst.E.E.* 22/4/04.
*Mechanical Construction of Revolving Field Alternators. D. B. Rushmore.	*Amer. Inst.E.E.* 22/4/04.
High Tension Oil Switches. Vogelsang.	*Elek. Ges. Cologne.* 24/4/04.
Five Years' Experience of the Effect of the Workmen's Compensation Act. W. H. Tozer.	*Royal Stat. Soc.*
Statistics of the World's Iron and Steel Industries. W. P. Digby.	*Soc. Arts.* 4/5/04.

Central Station Practice.

Articles.

Memoir on an Electric Regulator (concld.). Gin.	*L'Eclair Elect.* 26/3/04.
Oscillation of Alternating Current Machines Connected in Parallel. A. Sommerfeld.	*Elek. Zeit.* 7, 14/4 04.
A Study of Industrial Economy for Electrical Power-houses. Serial. Ponseel.	*L'Elec.* 9/4/04, 16/4/04.
Booster Calculations. W. A. Del Mar.	*Elec. Wld. & Eng.* 9/4/04.
Rational Calculation of Current Distributing Networks. Dr. E. Müllendorff.	*Elek. Zeit.* 14, 21/4/04.
Central Station Economy. T. H. Davies.	*Elec. Eng.* 15/4/04.
Liquid Fuel Burners. J. S. V. Bickford.	*Eng.* 15/4/04.
Burning Powdered Coal. H. J. Travis.	*Power. April, /04.*
The Selection and Testing of Lubricants. A. O. Doane.	*Power. April, /04.*
Lubricating Oils and their Properties. W. Davis.	*Power. April, /04.*
*Single phase Motors as a Means of Increasing Station Earnings. W. A. Layman.	*Jrnl. Elec. Power & Gas. April, '04.*
Earthing the Neutral Point in Rotary Current Plants. P. Humann.	*Elek. Zeit.* 5/5/04.

Electrical Work in Shops.

Articles.

Care of Electrical Apparatus. E. B. Clark.	*Westn. Elec.* 23/4/04.

Finance and Legislation.

Papers.

Running Powers. T. W. How.	*Try. & Lt. Rly. Assoc.* 6/5/04.

◆

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, *with names and addresses of manufacturers, will be given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.*

Electro-Physics.

Instruments for Laboratory Work. NALDER BROS. & Co., Westminster. Messrs. Nalder Bros.' full catalogue of general testing and scientific instruments has reached us. It is a most comprehensive volume, and gives full details of their manufactures. Amongst these we may mention, in addition to the well-known specialities of the firm, the "Flicker" photometer, the "Midget" insulation testing set, and the N.C.S. Universal potentiometer. The catalogue is artistically arranged, and would be extremely valuable upon the shelf of the electro-physicist.

CROMPTON & CO., LTD., Salisbury House, London Wall, E.C. The Crompton potentiometer is described and illustrated in a twenty-six page catalogue issued by this firm. In addition to a price list of the instrument and its accessories, there is a list of reflecting galvanometers, resistance boxes, and testing-room appliances. Pamphlet U 7 deals with electrical pyrometers.

Central Station Practice.

Pumps. G. & J. WEIR, LTD., Cathcart, Glasgow. We have been favoured with a copy of a catalogue which gives details in an elaborate manner of the now well-known Weir pumps. The catalogue is excellently illustrated, and contains particulars of the tandem compound, twin compound, tandem combined service, and service pumps of the firm. A valuable section is that in which steam and electrically driven pumps are compared.

Steam Traps. HOLDEN & BROOKE, LTD., Sirius Works, West Gorton, Manchester. Brooke's new steam trap and the "Sirius" steam trap, together with Brooke's patent bucket trap, are detailed in a sixteen page catalogue which has just reached us. The first-mentioned is specially suitable for central station work. We also gave particulars in the

Manufacturers' section last month of Green's patent valve, made by the same firm. It is specially valuable for central station work.

Miscellaneous.

Belting. Fleming, Birkby & Goodall, Ltd., West Grove Mill, Halifax. A handsome catalogue of 126 pages has reached us from this firm. It is divided into sections, giving particulars of leather beltings, textile beltings, belt fasteners, picking bands, india-rubber goods, wood pulleys, and card clothing. A final section gives some valuable hints on leather belting, together with a quantity of useful data.

Steel. The Steel Company of Scotland, Ltd., 23 Royal Exchange Sq., Glasgow. A well bound booklet, containing full particulars of the steel sections, which are a speciality of this company.

Fibre. J. Burns, 76 Little Britain, E.C. Price list, A 703, gives details and prices of "Delaware" vulcanised fibre.

Marine Engines. Ross & Duncan, Whitefield Works, Govan, Glasgow. A large and handsome catalogue, comprising marine machinery, land engines, boilers, and steam vessels, which are a speciality of this firm, has been sent us.

Gear Planers. The Gleason Works, Rochester, N.Y. A catalogue, which has reached us "from the other side" (from the Gleason Works), is a monument to the printer's art, while testifying to the enterprise of the firm in giving publicity to its specialities. The catalogue comprises some dozen leaflets, bound up with cord in a neat cover. The chief machines illustrated are automatic gear planers for bevelled gears, and each illustration is separately mounted with an artistic border on a loose sheet of art cover paper.

"Capyt." The Cape Asbestos Co., Ltd., 8 The Minories, E.C. A four page pamphlet describes the new insulating material "Capyt," which, we understand, is suitable for controllers, dynamo and motor bobbins, switch bases, meter cases, and wire conduits. The material is practically unbreakable, and can be turned, bored, tapped, sewn, nailed, screwed, perforated, or worked in any suitable way. From the same source we have received particulars of asbestos slates for roofing, ceilings, and lining walls and floors.

Files. The Ideal Syndicate, 2 Pancras Lane, Queen St., E.C. Particulars of the "Radiant" letter file, the "Pilot" file, and a number of specialities for office use have reached us from this company.

Forthcoming Events

A complete list of the meetings of various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, will be listed under order of date in this section.

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

Now open. Remains open till *December 1st, 1904.*

Colliery Exhibition, Royal Agricultural Hall, London.

June 25th to July 2nd, 1904.

Third International Congress of Mathematicians, Heidelberg.

August 8th to 13th, 1904.

Exposition Internationale au Grand Palais, Paris.

August to November, 1904.

Industrial Exhibition, Cape Town.

November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

The date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition (see note below). The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

The Tramways and Light Railways Exhibition, 1905, Agricultural Hall.

July 3, 1905.

Papers before Societies.

Royal Institution.

His Serene Highness Albert Prince of Monaco, on "The Progress of Oceanography." *May 27th, 1904.*

Prof. Svante Arrhenius, of Copenhagen, Hon. Mem.R.I., Hon. F.C S., on "The Development of the Theory of Electrolytic Dissociation." *June 3rd, 1904.*

St. Louis International Association of Municipal Electricians.

September 13th and 14th, 1904.

"Street Lighting: Principles Involved and Systems Used." A. S. Hatch.

"The Limitations of the Telephone for Fire Alarm Purposes." A. Bosch.

"The Inspection of Theatres from an Electrical Standpoint." W. H. Thompson.

"Methods of Testing." W. M. Petty.

Meetings, Conventions, etc.

National Electric Light Association.

27th Annual Convention, Boston. *May 24th to 27th, 1904.*

"Purchased Electric Power in Factories"; W. H. Atkins. "Decorative and Sign Lighting"; A. Williams. "The Sale of Electricity"; W. F. White. "Practical Notes on Steam Turbines"; F. Hodgkinson. "A Hundred Mile Transmission Line"; R. Howes. "Economy Test of 5,500-hp. Generator"; J. D. Andrew, W. F. Wells. "The Remote Control of Electrical Apparatus"; W. H. Cole.

Incorporated Municipal Electrical Association.

Annual Meetings (Derby, Nottingham, Sheffield), *June 29th to July 2nd, 1904.*

Programme, unless subsequently modified:

Derby, Wednesday, June 29th.

Morning.—Presidential Address. Paper: "The Commercial Practicability of Electric Traction by Surface Contacts"; C. E. Shawfield.

Afternoon.—Excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation.

Nottingham, Thursday, June 30th.

Morning.—Papers: "Polyphase Sub-stations, their Equipment and Working"; S. L. Pearce. "Some Notes on the Bristol Electricity Works Fire"; H. Faraday Proctor. "Boiler House Economies"; R. S Downe.

Afternoon.—Visit to electricity works and other works.

Evening.—Members' annual dinner.

Sheffield, Friday, July 1st.

Morning.—Papers: "The Financial Position of Municipal Electrical Undertakings"; Councillor Blakeway. "The Organisation and Management of the Meter Department"; A. J. Cridge.

Afternoon.—Visit to electricity works and other works.

Derby, Saturday, July 2nd.

Morning.—Annual general business meeting (members only).

American Street Railway Association.

23rd Annual Convention. St. Louis Exposition. *October 12th and 13th, 1904.*

International Electrical Congress, St. Louis Exposition.

Conventions will be held by the following Societies: the American Institute of Electrical Engineers, the American Physical Society, the American Electrochemical Society, the American Electrotherapeutic Association, the International Association of Municipal Electricians, the British Institution of Electrical Engineers. Delegates from the Société Internationale des Électriciens, the National Electric Light Association and the Association of Edison Illuminating Companies.

The following papers have been promised for section A, the section on theory, of which Professor E. L. Nichols is chairman and Professor H. T. Barnes is secretary:

Foreign—"Metallic Conduction," Professor Dr. Paul Drude; "Electrical Standards," Professor Dr. W. Jaeger; "Ions," Sir Oliver Lodge; "Magneto-Striction," Professor H. Nagaoka; "The Theory of Ionisaton by Collision," Professor J. S. Townsend; Secondary Standards of Lights," M. J. Violle; "Condensation Neuclei," Mr. C. T. R. Wilson; "Magneto-Optics," Professor P. Zeemann. American—"The Mechanical Equivalent of Heat as Measured by Electrical Means," Professor H. T. Barnes; "Atmospheric Neuclei," Dr. Carl Barus; "The State of Our Knowledge Regarding the Earth's Magnetism," Dr. Louis A. Bauer; "Magneto-Optics," Professor D. B. Brace; "The Absolute Value of the Electromotive Force of the Clark and Weston Cells," Professor H. S. Carhart and G. W. Patterson, Jr.; "The Electric Arc," Professor C. D. Child; "Coherer Action," Dr. K. E. Guthe; "Electrical Discharges in Gases," Professor E. P. Lewis; "Electro-Striction," Professor L. T. More; "The Unobtained Wave-Lengths between the Longest Thermal and the Shortest Electric Waves yet Measured," Professor E. Fox Nichols; "Standards of Light," Professor E. L. Nichols; "Magnetic Effect of Moving Charges," Harold Pender; "Electrical Theory," Dr. M. I. Pupin; "Alternating-Current Measurements," Dr. Edward B. Rosa; "Radioactive Change," Professor E. Rutherford; "Radioactivity of the Atmosphere," Professor J. C. McLennan; "Electrical Discharge in Gases," Professor J. Trowbridge; "Electrical Theory," Professor A. G. Webster.

Association of Railway Telegraph Superintendents.

Annual Meeting, Indianapolis. *June 15th and 16th, 1904.*

American Electro-theraupeutic Association.

Annual Convention, St. Louis. *September 13th to 16th, 1904.*

* * *

Miscellaneous.

[*These Notes are crowded out of their respective sections.*]

* * *

I.E.E. Students' Visit to Birmingham.

We have received the following from Mr. W. J. Williams, and in view of the importance of the students' section of the institution, we are pleased to give it notice:

Some forty members of the students' section of the Institution of Electrical Engineers visited the engineering works in the Birmingham district during the Easter vacation. Among many interesting and instructive sights, the erecting shop for large machines, at the works of the E.C.C. at Wolverhampton, seemed to leave the deepest impression. Some very fine machinery was seen at the works of Messrs. Willans and Robinson, at Rugby; and certainly one of the best (if not the best) testing houses for direct coupled sets was inspected at Messrs. Bellis and Morcom's works. A good lesson in the setting out of a large works was to be learnt from those of the G.E.C., at Witton. It is gratifying to think that the visit was a great success, both from the instructive and social points of view.

Electricity for the Household.

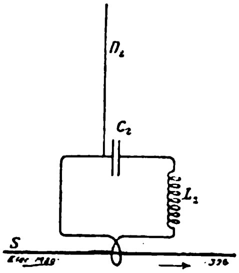
Recent improvements in the design and construction of oil-motors have presented a solution of the difficult problem of generating electricity on a small scale at a reasonable cost, and specialists have begun to realise the importance that small domestic installations may acquire in the near future. Several firms lately have been studying this question, and the Siemens-Schuckert Co. of Berlin, has recently introduced a typical design for this class of installation. The generating set consists of a dynamo coupled direct to a benzine or alcohol motor, a storage battery, and a small switch-board completing the equipment. The dynamo and motor have a common frame which is borne on springs to absorb the vibration, and the entire outfit can easily be stowed away in a cellar. The motor, of 3 to 4½ h.p. runs at 1,200 revolutions, this speed making direct coupling an easy matter. To ensure smoothness and regularity in the working, the dynamo is made U-shaped, and the rotating organs of the motor are placed in the lower part of the frame. The dynamo yields from 1·7 to 2·5 k.w., according to the energy absorbed. The cylinder, valve, and exhaust pipes are water-jacketed, the consumption of water being about 6 to 8 gallons per k.w. hour. By a special arrangement of rotating discs actuating small pistons, the lubrication of all the moving parts is entirely automatic. The storage-battery consists of 4 cells of 290 a.h. capacity; the maximum output, whether for charging or discharging, is 72 ampères. The whole installation is exceedingly simple and needs no trained engineer for its management.

A New Use for Inventors.

Probably most of our readers who are engaged in the manufacture of electrical apparatus might justly be termed inventors, as it must frequently be necessary for them to devise new types of machinery, and new tools or appliances for the more economical and satisfactory production of work. There are many engineers and mechanicians who are quite competent to deal in this way with the difficulties suggested by everyday work, but who are not prone to look abroad for new ideas, and moreover have little time at disposal for speculative studies. Another class exists, the members of which rarely possess that peculiar ability which leads to industrial and commercial success, and their minds are generally full of new ideas which they hope others may be persuaded to take up and exploit. Many inventors of the latter type are unable to work out their ideas, either from lack of perseverance or lack of capital, or from a combination of these deficiencies, and sometimes from a superabundance of fresh ideas, which continually sets them off in new directions. In this country, the habitual inventor is usually unattached, and he seldom does much for himself or for his fellows. In Germany and the United States, however, organised attempts have been made to catch and harness the inventor, so that he may be utilised in a practical way. The scientific research laboratories established in connection with many large industrial establishments in Germany serve to effect a union of the inventive faculty with commercial ability. A very similar system is pursued in the United States, where men endowed with inventive genius of a high order are maintained by large engineering concerns for the purpose of inventing new forms of apparatus, which are afterwards exploited by the firms concerned. Left alone, such inventors might do very little good, but encouraged by a permanent source of income and stimulated by the hope of greater rewards in the event of success, they have done much for the various engineering industries of the United States. The combination to which we refer clearly suggests a new use for British inventors, and one which we recommend in all earnestness to our readers.

A New System.

A QUITE new method of receiving in wireless telegraphy has lately been invented by Drs. Simon and Reich, whose experiments on the production of trains of undamped electrical oscillations are well known. In this system, the properties of the Poulsen Telegraphone and the Rutherford solenoidal detector are utilised in combination to produce the desired result. The principal can be easily seen from the diagram. In this D_2 is the receiver antenna connected to a closed resonant oscillating circuit C_2L_2 in which are included some turns embracing a magnetically saturated steel wire or band, S, which is moved rapidly along through the solenoid. When waves arrive, the oscillations in the resonator circuit demagnetise the steel wire more or less according to their strength, thus transferring the variations to the wire. On the wire now being drawn through a telegraphone arrangement, the variations in the magnetisation will give rise to currents which can be detected with a telephone or galvanometer. It is obvious that if the telegraphone arrangement is placed near to the demagnetising apparatus, the message can be read off at once on the telephone as received at the naturally higher speed capable of being employed with telephonic reception. The wire is wound round on a drum in the usual way, and can be passed through again later for checking or recording purposes. The inventors consider that with this method a simultaneous reception of different waves is quite possible.



Simultaneous Telephony and Telegraphy.

IN a recent issue of the *Elettricista*, an experiment made at Ferrara by Prof. Battelli and Prof. Rigi on the Turchi-Brunè system of simultaneous telegraphy and telephony is described. The working of the apparatus was so satisfactory as to remove all doubts as to the practicability of the method. After the Bologna Telegraph Inspector had allowed those present to test the various devices used in connection with the experiments (when the most recent device where the differential coil is replaced by an ordinary line coil aroused special sensation by its simplicity and efficiency), telegraphing and telephoning was carried out simultaneously, with a view to contradicting the statement that the scheme would allow of protecting the telephone receiver only against disturbing currents of very low frequency. In fact, the telephonic conversations were heard with perfect distinctness and strength, while current impulses of very high frequency were generated in the same wire by means of a Wheatstone telegraph apparatus.

The Jungfrau Railway.

THIS most interesting of mountain railways, now rapidly progressing towards completion, starts from the Scheidegg station, at an altitude of 2,064 metres, where it joins the steam line from the Wengernalp. It then ascends, in the open, except for a distance of 87 metres, to the Eiger glacier, at an altitude of 2323 metres, where it enters the great tunnel, which, when completed, will be about 10 kilometres in length. It then proceeds by the Rothstock to Eigerwand, at each of which points there is a station. The line is at present only completed as far as the Eigerwand station. It will then continue round the south side of the Eiger to the Eismeer, then to the Jungfraujoch station at an altitude of 3,421 metres. Thence it will proceed at an incline of 1 in 4 to the Jungfrau station, at a height of 4,093 metres. A vertical lift will carry passengers from the last station to the summit, 73 metres higher.

It is of interest to note that electric percussion borers are being employed in the great tunnel.

The power station is at Lauterbrunnen, where a fall of 40·80 metres supplies 2,650 horse-power by means of turbines with automatic regulation. Three-phase current is supplied at 7,000 volts and 38 alternations, by the generators, and transformed down to 500 volts at sub-stations.

The high pressure conductor is laid in a channel cut in the side of the tunnel, and protected by wire netting. The two trolley wires are carried by span wires, fixed to wooden posts in the open, and, in the tunnels, to bolts cemented into the walls. Three-phase motors are employed, two of 120 h.p. each to each locomotive. Two independent mechanical brakes are employed in addition to the electric braking.

The Institution of Civil Engineers.

AT the annual general meeting of the Institution of Civil Engineers, held on Tuesday, April 26, Sir William H. White, K.C.B., President, in the chair, the result of the ballot for the election of Council for the sessional year 1904-5 was declared as follows: — President, Sir Guilford Molesworth, K.C.I.E.; Vice-presidents, Mr. F. W. Webb, Sir Alexander Binnie, Dr. Alex. B. W. Kennedy, F.R.S., Mr. W. R. Galbraith; other members of Council, Mr. C. N. Bell (Wellington, N.Z.), Mr. C. A. Brereton, Mr. R. Elliott-Cooper, Col. R. E. B. Crompton, C.B., Mr. W. J. Cudworth (York), Mr. G. F. Deacon, LL.D., Dr. F. Elgar, F.R.S., Mr. R. A. Hadfield (Sheffield), Mr. G. H. Hill, Mr. C. W. Hodson (Bombay), Mr. J. C. Inglis, Mr. G. R. Jebb (Birmingham), Mr. T. C. Keefer (Ottawa), Mr. A. G. Lyster (Liverpool), Mr. J. A. McDonald (Derby), Mr. W. Matthews, C.M.G., Sir Charles Metcalfe, Bart. (Cape Town), the Hon. C. A. Parsons, F.R.S. (Wylam-on-Tyne), Mr. A. Ross, Mr. W. Shelford, C.M.G., Mr. Alexander Siemens, Mr. John Strain (Glasgow), Sir John I. Thornycroft, LL.D., F.R.S., Prof. W. C. Unwin, B.Sc., F.R.S., Sir Leader Williams (Manchester), Mr. A. F. Yarrow.

The Institution of Civil Engineers.

THE Council have made the following awards for papers read and discussed before the Institution during the past session:—A Telford Gold Medal to Major Sir Robert Hanbury Brown, K.C.M.G., M.Inst.C.E., a George Stephenson Gold Medal to Mr. G. H. Stephens, C.M.G., M.Inst.C.E., and a Watt Gold Medal to Mr. Alphonse Steiger, M.Inst. C.E. Telford Premiums to Mr. E. W. DeRusett, M.Inst. C.E., Mr. Hugh Robert Mill, D.Sc., LL.D., Mr. Alexander Millar, Assoc.M.Inst.C.E., and Mr. T. E. Stanton, D.Sc., Assoc.M.Inst.C.E.; a Manby Premium to Prof. J. Campbell Brown, D.Sc., and a Crampton Prize to Mr. L. H. Savile, Assoc.M.Inst.C.E. The presentation of these awards, together with those for papers which have not been subject to discussion, and will be announced later, will take place at the inaugural meeting of next session.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

No. 6. Vol. I. LONDON. June 29, 1904.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The Annual Convention of this important American Association was held on the 29th May, consequently our last issue was in the press before any detailed reference could be made in it to the meeting of this representative assembly of electrical men. The Convention was held in Boston, Mass., which fourteen years previously was chosen as the meeting place of the Association, but under vastly different conditions, and with less effect than was noticeable on the present occasion. In 1887, neither the Association or the electrical industry were very old, so that the meeting this year was of historical as well as electrical interest. The Association is representative of the electricity supply interests of the United States, and may be compared in some ways to our I.M.E.A.. save that it is not purely municipal in tone. During its twenty-six years of existence it has grown rapidly, and, after varying fortunes, is among the most powerful of electrical bodies of its kind in any country.

The programme this year has been one of exceptional interest, including many papers of value to central station men especially. As is usual, the President's address, from Mr. C. L. Edgar, opened the proceedings, and his remarks chiefly related to the Association administration and organisation. He announced that the offices of the Association would be placed in the Union Engineering Building, New York—Mr. Andrew Carnegie's gift—where direct intercourse with other engineering and electrical societies would be possible, to the great advantage of the Association. This privilege will mean much to the work of the Association, and should materially assist in the elevation of its aims and motives. A new class of membership was suggested to counteract the falling away of members of companies merged into a large purchasing concern, such companies being wound up by certain state regulations, and consequently no longer eligible for membership.

An association of this character, and of such long standing in the industry, must naturally possess valuable records of past experience in the reports of its proceedings. This matter has been, to all intents and purposes, lost to the electrical world for want of a comprehensive index. Realising the necessity for some such means of reference, steps have been taken to compile an index, which will be published in separate form with the proceedings of the present Convention. No less than 27 papers were down for reading. Of such a number but a few could be regarded of real importance. The progress report always makes interesting reading, and

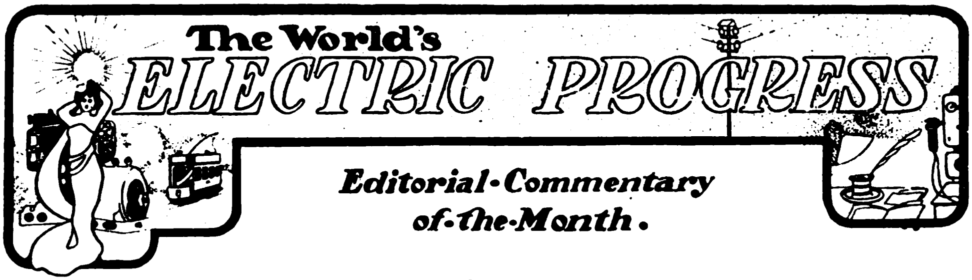
B

when we can peruse this in detail some valuable figures will be at our readers' disposal. We can only quote briefly from some comparisons between the U.S.A. and other countries in plant installed. In Spain 5 watts of new apparatus per head of population were installed in 1903, in Germany 7·5 watts in 1902, in England 12 watts in 1902-3, and in U.S.A. 16 watts in 1902. Mr. W. S. Barnes read a paper on a 250-550 three wire system at Narragansett where 250 volt lamps and 500 volt motors are in regular use. The system is at present undergoing alteration. The subject of lamps and lighting was fully dealt with, and much valuable data was unearthed in the discussions.

Lost and unaccounted for current, which figure largely in some supply station accounts, were the subject of Mr. C. W. Humphrey's paper, he citing the experience and method of the Denver (Col.) Gas and Electric Light Co. Where law and order are not strictly enforced it is no matter for surprise that the bulk of the loss was due to thefts of current. Unfortunately, or fortunately shall we say, the loss cannot be so readily accounted for in many stations. Still, that the problem can be tackled and with a reduction in the unaccounted for current, is evidenced by the fact that a feeder, changed from a 1,000 volt individual transformer to a 2,000 volt three wire secondary network, reduced the transformer losses no less than 60 per cent. The ratio of sales to output was also increased from 59·3 per cent. to 80·5 by proper attention to the reduction of losses. Some tests of a 5,000 h.p. set at the Waterside station of the New York Edison Co. formed the subject of Messrs. Andrew & Wells' paper. For outputs of from 2,500 to 4,500 kw. steam consumption varied between 17·22 to 18 pounds of water per i.h.p. hour of net output at the generator terminals. The best test showed an economy of 11·93 pounds of water per i.h.p. hour or 16·78 pounds per kw. hour. A decided disadvantage was noticeable in the use of a receiver reheater and steam jacket in this type of engine. Increasing the vacuum from 25·3 to 27·3 inches reduced the water consumption by ·07 pound only. Gas engines were discussed to no little extent, one speaker remarking, among other things, that the present gas engine was relatively no better developed than the steam engine during the life of Watt. Another member considered that the gas engine was best placed when taking care of a 24 hours' load, as it then worked at its highest efficiency. Other statements on these subjects must be left until we receive the full report of the proceedings.

The reports on subjects directly affecting central station interest, which are the feature of the Annual Convention, deal with several trenchant matters this year. The steam turbine received due consideration, as did factory electric power, though the report on advertising methods would seem strange to central station men in this country, where so little is done. In the discussion on this topic some of the tactics in vogue came to light. One engineer, in a town of 50,000 inhabitants, distributed 4,000 booklets a week, in the street cars, the booklets being held in a metal holder and changed daily. In another case, factories inefficiently equipped with motors were altered and improved, and the change in the motor bills made a pretence for securing further business. Other members disagreed upon the efficacy of promiscuous distribution of literature on the grounds of inability to follow up the man interested. The President, who is also President of the Boston Edison Illuminating Co., stated in response to a query that his company spent 5 per cent. of its income in advertising and soliciting new business. An instructive paper was read by Mr. Ayer, on "Electric Heating," in which he advocated that kitchen and heating outfits should be installed free, as was done by gas companies. The average demand, for a family of four to eight persons, was 2 kw., or two-thirds the house service. The load did not interfere with the peak in any way.

The Convention was a great success, being attended by over 400 delegates. There was an exhibition also in which almost 100 manufacturers were represented. The growth and present strength of the Convention amply testify to the position of central station work in the United States. A representative association combining central station interests of all kinds in this country would be of immense benefit to the industry and more especially could public and private interests be involved therein.



The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month.

This section will consist of several pages of bright, informative leaderettes, reviewing and commenting upon the principal events of interest in the electrical world. They will be mainly written by the Editor-in-Chief in collaboration with the permanent Associate Editors, each being an expert in his own special department, and some of whom are leaders of thought and scientific opinion. With this combination of talent, readers of *The Electrical Magazine* may look to this section for an exceedingly interesting and instructive review of the march of events in the world of electricity.

❧

Our New Volume. THIS issue completes the first volume of *The Electrical Magazine*, and we feel that our thanks are due to the subscribers and contributors who have so heartily supported us in making each issue better than its predecessor, and placing this journal in a position of undisputed authority. Its success is the more gratifying when we consider the number of technical journals now before the public, each claiming some distinctive feature. This magazine was started to fill a distinct gap in technical literature, and, what is more, has successfully filled it. The reason for its rapid ascendency lies mainly in the fact that it has lived up to its programme. In six short months it has attained a position entitling it to be quoted as a standard work. Every day its influence is becoming more marked, and it is being recognised in electrical and industrial circles everywhere as an indispensable adjunct to the work of the busy business man. With our next issue a complete index will be included, and a handsome binding case will be supplied to each annual subscriber. We call attention to our Special Offer at end of magazine.

❧

The Telegraphone. VALDEMAR Poulsen's telegraphone, since its invention in 1900, has been developed to the point of commercial utility, and will shortly be on sale in this country. We have recently inspected the latest type of the apparatus, and must express our satisfaction at its extreme simplicity, compactness and adaptability to a variety of uses. It will record and reproduce sounds of every quality, register a conversation on a telephone, and act as a distributor of news or information. Compared with the phonograph, its principles place it well ahead of that instrument, as they entirely obviate the constant attention so common to Edison's invention. From our inspection and trial of the latest type we can safely prophecy a commercial future for the machine, especially among electrical men. We have made arrangements to present our readers with a special illustrated description in our next issue.

❧

Automatic Telephony. DEVELOPMENTS in the telephone world point to the speedy appearance of the automatic exchange as a pronounced rival of the manual boards now in common use. Strange as it may seem, the perfected exchanges employing human aid as the media between subscribers, will enjoy but a short life judging by the strides which automatic operating is now making. That the human element be reduced to the greatest extent possible in telephone exchange work is highly desirable, but whether the claims of the new comers can be substantiated in practice is another matter. It is only reasonable that the electrical energy used to transmit sound waves should be employed to perform operations now entailing much expense and ofttimes vexatious delay. This branch of telephone work has claimed our special attention, and next month, in the Telegraph and Telephone section, a fully illustrated account will be given of a prominent American system shortly to be exploited in this country. In addition, we shall publish some particulars of an automatic exchange described by one of our American Associate Editors.

❧

To Central Station Men.

In our Central Station Practice section this month will be found articles from station engineers who have responded to our request that the section be made the medium for exchange of ideas between electrical engineers responsible for plant and mains. So much capital is involved in power house operation and the distribution of energy, that enough cannot be written on the subject to circulate the opinions of those directly concerned with the maintenance of a supply system. Consultants naturally watch keenly the manner in which their schemes are conducted, but they seldom advise on the *running* of the station. Even chief engineers, nominally answerable for the schemes they control, are in the hands of their assistants, and upon their ability success will generally depend. The man down among the details bears the heat and burden of the day, and in the majority of cases that man is responsible to the chief. He is not the stoker, or driver, or fitter who does what he is told, but the schemer continually watching how this or that may be improved, altered, or scrapped. Central station development has produced a type of man who can only hold his post by constant attention to detail, and to do this he must widen his knowledge of the problem he is engaged upon. Our Central Station Practice section gives him this opportunity, and we hope that those engineers who read and profit by the articles reproduced from time to time will also respond by an exchange of thought which shall be equally beneficial to their *confreres*.

Telegraph Instruments.

The old instinct of the Britisher which has been to make everything massive and solid—sometimes in excess of the requisite strength at which a machine is to function—is still alive in the manufacture of telegraph instruments. The younger industry, that of telephones, unfettered by early prejudices, has aimed to condense everything into the smallest possible space, and to use the minimum amount of material, consistent with safe operation. But in turning out telegraph apparatus, manufacturers—and we fear the officials who use them—still cling to the massive proportions which were in vogue fifty years ago. Much of the brass, iron, and mahogany, employed in sounders, inkwriters, needle instruments, lightning dischargers, keys, and commutators, might easily be saved if slighter parts were adopted, even if present designs were adhered to. In some cases the adoption of a pattern such as is used in telephone working would in itself be economical; for instance, the lightning arrester of carbon, mica, and fuse coil, which is far cheaper than one of massive brass plates, often seen in telegraph offices. The new telegraph switchboards are following modern designs, and we hope that other apparatus may receive attention on similar lines. In this connection it would be worth while for telegraph manufacturers to find a substitute for platinum for contacts, as has been done in telephone switchboard work, as well as in many telephones. There is at present apparently a great waste of a very costly metal which might be obviated.

❧

Remarkable Telephone Statistics.

The chief statistician of the Department of Manufactures in the Bureau of the Census has recently issued a preliminary report on the telephone systems of the United States of America for the year 1902. Space will not permit us to give full particulars of this in this issue, but we can present a few items which will be of some interest. There are 4,151 systems in use, with 4,350,486 miles of single wire, and 2,315,297 telephones of all kinds. These represent a total number of subscribers 2,137,256, with 10,361 public exchanges, 7,883 private exchanges, and 10,842 manual switchboards. The magneto system still predominates with 10,005, as compared with 837 common battery systems. The number of talks make up some remarkable figures, totalling 5,070,555,345, and of these local exchanges dealt with 4,949,850,491, and long distance and toll were accountable for 120,704,854. The total number of salaried officials and clerks was 14,124, and of wage earners, linesmen, etc., 64,628. In our next issue we shall hope to give in the Telephone section the financial figures, which also make instructive reading.

❧

What Electric Traction Can Do.

FOR interurban service, conclusive evidence of the value of electric traction on railways is continually forthcoming. The New York elevated lines are now entirely operated by electricity, the conversion having occupied two years, and from results, comparing the working of the lines under the old and new conditions, some remarkable figures are obtainable. The number of passengers carried during the year ending February, 1904, was 273,133,242, an increase of 37,318,852 over the preceding year. The total car mileage for the same period was 60,730,337, an increase of 12,870,859, or, expressed in percentages, 15·85 and 26·9 per cent. respectively. Such figures should impress the railway companies of this country operating suburban trains by steam. Attention has frequently been called to the overcrowding of early and late trains running in and out of the Metropolis, and to the ready solution of the difficulty offered by electrification ; but, doubtless, railway managers are keeping record of the results of trains operated electrically before coming to a decision. The above will afford some food for reflection.

❧

The Iroquois Theatre Fire.

A REPORT on the historic calamity at the Iroquois Theatre, Chicago, has been issued by the British Fire Prevention Committee, the bulk of the report comprising a paper on the occurrence by Mr. E. O. Sachs. The entire document makes instructive reading, though to electrical men the chief items of interest are contained in references to the arc lighting. The building comes in for the most adverse comment, and had this been properly designed, and further precautionary measures taken, many lives would have been spared. The tale of lack of fire precautions, neglect to drill employees for emergencies, incompetency of builders and inspectors, etc., has been told *ad nauseam*; consequently, we will not burden our readers with further recital. The appearance of the report may, however, give rise to the belief that electricity was the main cause of the disaster. That scenery was ignited by sparks from an open arc lamp there can be no denying, but so slight an occurrence would not in itself have led up to so frightful a result, had not other circumstances contributed to that end. With proper precautions the arc lamp is as safe an illuminant for stage effects as can be found, though where its dangers are disregarded, and light scenery brought into its proximity, the ignition of such material can be the only consequence. The fire has taught its lesson, but very little of that lesson has needed learning by electrical engineers. They will chiefly profit by redoubling their precautions where open arc lamps are used. The arc light operator, curiously enough, was censured by the jury for gross neglect of duty, but we fail to see how he could prevent the falling of the "mushrooms" from his arc lamps. Surely the management was at fault for its injudicious arrangement of the scenery and the open arcs.

❧

From Telephone to Flying Machine.

PROFESSOR GRAHAM BELL is evidently not content to rest on his laurels and enjoy, like many inventors, the fruits of his labour in retirement and leisure. Having achieved fame through the invention of the telephone, he now lays claim to immortal remembrance as the inventor of a practical flying machine. The venerable professor has been conducting experiments at Burdetts, Nova Scotia, with a special kite, the result of much patient investigation of aëroplanes and bodies moving in the air. This takes the form of a tetrahedron, and is built up of a number of triangular kites. Considerable success seems to have attended the experiments just carried out, and, with this encouragement, the professor is now working on a suitable motor for the propulsion of a kite constructed to carry a man. If these experiments teach nothing else, they show how much capital is needed for conducting such trials; for the professor is a very rich man, having, doubtless, reaped the reward of his labours in the telephone world. We shall look forward with considerable interest to the results attained by so distinguished a scientist in a decidedly difficult field, though, judging by the progress so far evident, the prospects of material success are well in sight. The same zeal evinced in the telephone world, if carried into the sphere of aëronautics, will surely be content with nothing short of complete success.

The Zossen Trials.

Mr. Alexander Siemens presented some valuable data at the last meeting of the session of the Institution of Electrical Engineers, on the high-speed railway trials conducted over the Marienfelde-Zossen military line. The thoroughness with which Germans undertake any task is fully borne out by the trials themselves and the manner in which their results have been recorded. Mr. Siemens pointed to the difficulties overcome and the *minutiæ* grappled with to secure success, even to the balancing of the areas of the two sides of the collector arm to counteract wind pressure. The trials dealt with were those conducted late in 1902, which, from a speed standpoint, were inferior to those held in the autumn of last year. They were, however, none the less instructive for this. The discussion, though short, was productive of trenchant remarks, the majority of the speakers dwelling on the enterprise of the German Government in financially supporting the experiments, contrasting this action with that of our own Government, whose reticence in furthering scientific research is too well known to need comment. General congratulations were extended the syndicate and its engineers responsible for the trials, while the indebtedness of the industry to Germany for its pioneer work in high speed railway work was also expressed. Mr. Mordey, whose articles on one-phase railway methods are appearing in this journal, thought the trials indicated how "it should not be done," and concluded his remarks on one-phase railways —especially on the Ward-Leonard system (see our third and fifth issues)—by saying the syndicate had discovered at the termination of their experiments that the one-phase method commended itself to them, and would be given a trial in future.

The Telegraphs of the United Kingdom for 1903.

Notwithstanding the growth of the telephone system, the number of telegrams sent over the Post Office wires shows an increase of 2.3 per cent. over the number sent in the previous year, and this applies to all classes of messages. The enormous total was over ninety-two millions. To meet the increased demand by the public 347 more offices were opened, making an aggregate of nearly ten thousand. The extensions of the underground circuits to the north have already been noticed in our previous issues. We think it a matter for much regret that the scientific work done by the officers of the department is not detailed in the Post Master General's report. The great success which has been achieved in building up this great system of telegraph and telephones in the past thirty-four years has been largely due to the conspicuous ability of the technical officers of the department. Lately, in introducing and arranging for new underground telephone systems, the same painstaking and assiduous officials have been called upon day by day to master special and unforeseen difficulties, and although the statistics of the work done are given, no credit is accorded the officers concerned. It must be remembered in commercial undertakings, the services of engineers such as the Post Office possesses, as well as those of technical supervisors, would often be rewarded by higher emoluments than are granted in the public service; and as these are not forthcoming in a public service, it would be a graceful thing in a Government report to give praise where it is deserved.

American and British Mechanical Engineers.

Between May 21st and June 3rd, the American Society of Mechanical Engineers held a joint meeting with the British Institution of Mechanica

Engineers, at Chicago. A long and varied programme was got through, quite a large number of papers being down for reading. Three of these dealt with the steam turbine, treating with the De Laval, Westinghouse Parsons, and Curtis types respectively. The first was considered in respect to its suitability for driving fans or centrifugal pumps, and was of purely mechanical interest. The paper on the second type, after reference to the machines now on the market, gave a detailed description of the machine, and this is the best we have yet seen on the subject. Various practical considerations of the mechanical construction of present types were entered into, reasons being given for what might appear at first sight peculiarities of design. Speaking of re-heaters, the author, Mr. F. Hodgkinson stated that exhaustive tests pointed to their being of little or no value in increasing the economy of a turbine. Moisture is, however, responsible for a greater steam consumption to the extent of twice its percentage to that of steam. Elaborate flexible bearings were regarded as unnecessary where the speed did not exceed 1,200 r.p.m. The author, in the course of his remarks, referred to the use of induction generators with turbines, and if his statements are borne out by subsequent experience, some remarkable changes in dynamo design will result. The excessive magnetic leakage, common to all inductor generators, with its attendant increase in material required in both core windings, has restricted the use of such machines, but if we are to believe Mr. Hodgkinson an increase of speed does away with these undesirable features. Instance, with a two pole 60 cycle induction generator of 500 kw., running at 3,600 r.p.m., the power factor might be brought as high as 98 per cent., or higher at full load, and the total efficiency would be greater than present generating machinery. The prospect of operating turbines with inductor generators presents conditions approaching the ideal, and if commercially realisable, will improve the conditions of supply while reducing the capital cost of generating plant. Mr. W. L. R. Emmett set forth the claims of the Curtis turbine with respect to its rivals. He also referred to the footstep bearing, stating that no trouble had been experienced with it. A special brake was, however, provided, to come into action and support the revolving part in case of failure. This brake also served to stop the machine as a 5,000 kw. set would run 4 to 5 hours after steam was shut off unless brought to a standstill.

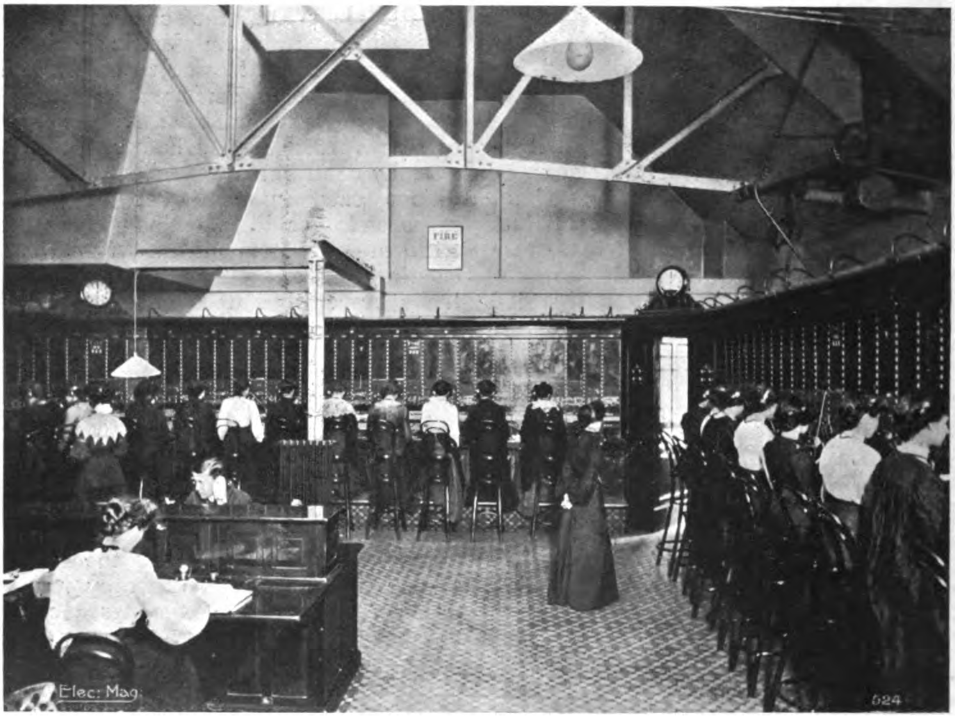
* * *

Railway Electrocutions. THE newly-electrified lines in the North and West have already been responsible for two deaths each by the contact of persons with the third rail. Circumstances like these present the scientist with food for reflection on the varying "internal resistance" of the human body and the conditions under which it can resist an electric shock. So diverse are current opinions on death by electricity, due to accidental contact with live metal, that conclusive evidence is not always forthcoming whether electricity actually contributes to other physical conditions causing death, or is directly responsible for it. Deaths among electrical men are comparatively rare, though exciting "moments" are on record when the survivor has recovered to tell the tale. Electricians are continually being "shocked," and are none the worse, perhaps because the experience excites no unpleasant sensation or induces no nervous disturbance. In the lay mind, however, there exists a horror of electricity sufficient in itself to cause a fright which would mean death to anyone of a weak constitution. A change in the system, as would be induced momentarily by the passage of an electric current, generally requires prompt adjustment of the nerve centres to allay fear and restore any temporary unbalancing of the mind. Where this adjustment cannot be made quickly enough, and where, in addition, a sense of fear previously existed, the effects of electricity are magnified to the extent evident in the recent cases of death. We do not imply that every electrician can stand a 500 volt shock, but it is generally recognised that contact with metal at that pressure is not accompanied by death under normal conditions.

The accidents bring up the question of protecting the third rail, at stations, if not throughout its length, and, should any more occur, the necessity for such protection will doubtless force itself upon the companies in question. Still, we sympathise with them, in that where other companies employing similar construction have been comparatively free from fatal accidents, they as pioneers in this country should suffer. As in so many other things, so with third rail electric railways, *experientia docet*, and the British public must learn.

❧

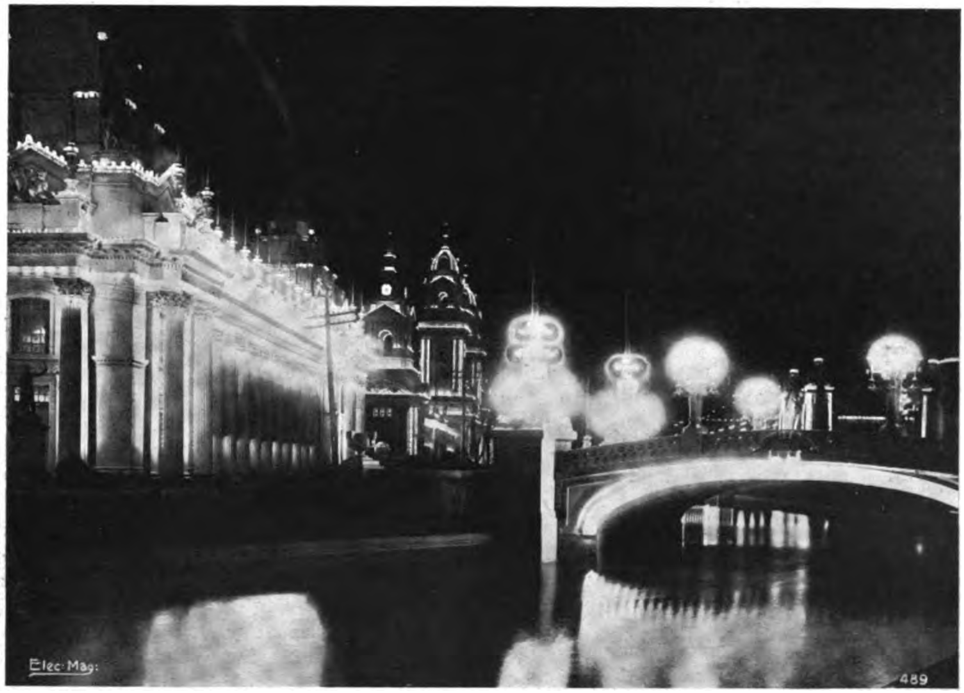
The New Holborn Exchange. We recently had the pleasure of inspecting the new Exchange opened in Holborn by the National Telephone Company. The central battery system has been adopted, this being the latest employed for telephone work. By the concentration of the entire energy for ringing and speaking at the Exchange much annoyance is avoided, and those parts of the system likely to give the greatest trouble—small batteries and magneto generators—are always under the eye of the company's servants. Of course the work of small cells and generators is combined in one large battery, and a single generator performing the functions of ringing, "busy back," and intermittent ringing, etc. The assembly of the apparatus has been well thought out, and there would seem to be little likelihood of trouble arising at the exchange. We reproduce a photograph of a portion of the operating room, the remainder being out of sight behind the wall on the left. The switchboard is 223 ft. long, and is fitted for 4,000 subscribers, another 1,000 being in process of connection. There are 99 operators at present engaged. When the exchange is completely coupled there will be little short of a million working contacts on the board, and 2,900 miles of cable, involving 1,169,000 soldered joints. The Exchange, in conjunction with others in London, serves an area of 634 square miles. The new Exchange replaces that installed at Holborn Circus, the change over being made towards the end of May. We have obtained particulars for an illustrated account which will appear in our next issue, when we shall reproduce diagrams of the working connections.



New Holborn Exchange of National Telephone Co.

The London Traffic Commission.

THE concluding evidence before the London Traffic Commission was heard on June 3rd, Mr. J. Clifton Robinson being the last witness. His evidence makes very interesting reading and contains much material not directly bearing on the subject of London's traffic, if one considers the problem of the City proper. Mr. Robinson's extensive experience with the L.U.E.T. lends weight to his opinion, as probably no tramway combination has made such strides in the face of determined and deliberate opposition as has the company of which Mr. Robinson is manager and engineer. He strongly supported the suggestion that a powerful tribunal be formed with full authority to deal with the problem and to include cab, omnibus, tubes and tramways within its purview. Such authority should act quite independently of municipal interest or interference, but it should not be formed in haste. The tribunal to consist of five well-paid members, appointed for a fixed term, and to sit all the year round and not during the Session of Parliament. Mr. Robinson also gave his views, at length, on the powers to be conferred on the tribunal. He made an interesting statement on the subject of intercommunication between tramways and tubes, which, if carried into effect, should confer great benefits on the London travelling public. His company, he pointed out, had previously sought powers for the arrangement in question. This was to construct an electric subway at Hammersmith, giving access to trams to the platforms of the underground Electric Railway. By this the tram service would be in complete connection with the tubes, and convenient through bookings could be arranged to all parts.



ST. LOUIS PALACE OF ELECTRICITY AND LAGOON AT NIGHT.

❧

St. Louis Exposition at Night.

As the magnificent exhibit palaces, winding lagoons, cascades, gardens, and statuary present a beautiful picture in the glare of day, so no less attractive is the Ivory City when the shadows of the night soften its outlines for a moment only before a flood of pure white light bathes the immense structures and brings them into bold relief, to be followed by the changing hues through the whole gamut of the spectrum. It is a sudden transformation from the material world to fairyland. By ingeniously contrived electric lights the whole picture is flooded at night with changing colours: at one time violet, then to amber, then emerald, crimson and amethyst, and on through various colour combinations following one upon the other so skilfully that the spectator is hardly conscious of the change until it has been completed. But through all these changes the great cascades retain a distinct tint. Mercury vapour lamps are cleverly concealed in the bases of the sculpture lining the sides of the cascades, the rays being thrown from concealed reflectors through small windows at an angle that will not meet the vision of the spectators from any point of view. In this light the tumbling waters of the cascades have the appearance at one time of a ghostly phosphorescent torrent, at another moment of floods of opal gems, and again of a cataract of living flame.

Every source of the wonderful kaleidoscopic effects is ingeniously hidden. It is possible to pick out different parts of the hill and its structures in different colours. Thus, while the Festival Hall in the centre is a rose colour, one arm of the Colonnade of States orange, the other violet, and the twin pavilions emerald, the whole splendid effect is attained without confusion of colours. An electric fountain, that is a thing of beauty and a riot of colour surpassing anything of the kind ever displayed, occupies a point of vantage on the grounds. The exhibit palaces at night appear to be giant cornices of white light, supported at four corners and the centres by immense pavilions of light. The rest of the façades are so treated that their massive columns are silhouetted against the screen walls, which are banks of blazing white lights.

ST LOUIS EXHIBITION. THE PALACE OF ELECTRICITY AT NIGHT.

The next issue of The Electrical Magazine commences Vol. II. A limited supply of copies of each number of Vol. I are still in stock. Those desirous of having a complete set can now secure same by making early application. New subscribers will obtain the privileges enumerated on tinted supplement at end of this issue.

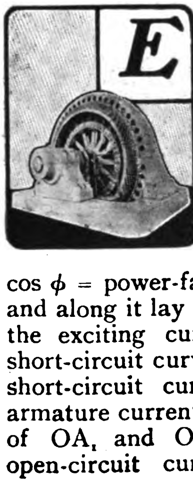
The articles under this section being of general interest to electrical men, are not classified under the ordinary sections of the magazine.

THE THEORY OF ALTERNATORS.—VI.

By ALFRED HAY, D.Sc., M.I.E.E., etc.

(Concluded from page 472.)

ROTHERT'S METHOD.



ENTIRELY different from the construction employed by Behn-Eschenburg is that introduced by Rothert, which is as follows:—Let (in Fig. 16) OA_1 represent the exciting current. Draw a line OA_2, making an angle of $90° + \phi$ (where $\cos\phi$ = power-factor of load) with OA_1, and along it lay off a length OA_2 equal to the exciting current (obtained from the short-circuit curve) required to produce a short-circuit current equal to the given armature current. Find the resultant OA_r of OA_1 and OA_2, and, referring to the open-circuit curve, read off the open-circuit E.M.F. corresponding to the exciting current OA_r. This open-circuit E.M.F. represents the required value of the P.D.

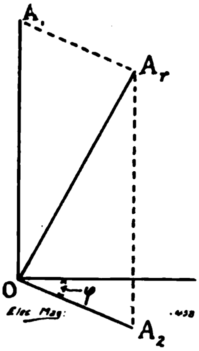


FIG. 16.

In order to determine the load characteristic for a given value of ϕ, we may use the construction shown in Fig. 17. With O as centre and radius equal to the constant value of the exciting current, describe the arc AC D. Draw OA, making an angle ϕ with the vertical axis. Taking any value of the armature current, find by reference to the short-circuit characteristic the exciting current OB corresponding to it. From B draw BC parallel to OA. Then BC gives the resultant exciting current, and a reference to the open-circuit curve enables us to find the P.D. By repeating the construction for several values of the armature current, we determine a number of points on the load characteristic.

COMPARISON OF BEHN-ESCHENBURG'S AND ROTHERT'S METHODS.

In Behn-Eschenburg's method, we compound E.M.F.s; in Rothert's, we com-

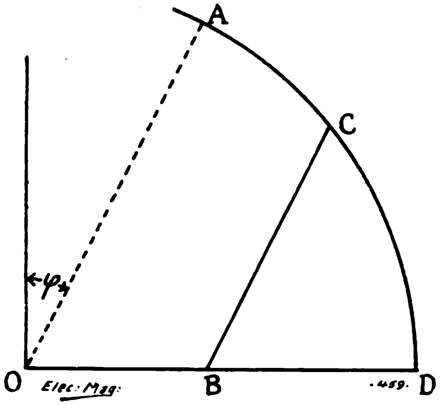


FIG. 17.

pound *ampere-turns*. The former is a legitimate proceeding; the latter is more than doubtful, as the vectorial composition of ampere-turns (or magnetising currents) has, strictly speaking, no meaning, and could be clearly interpreted in certain special cases only.

The great merit of both methods is their extreme simplicity. On comparing the values obtained by the aid of these methods with experimental results, it is found that, as a general rule, Behn-Eschenburg's method yields values of the P.D. which are *lower*, while Rothert's yields values which are *higher*, than those found by experiment. Thus the first method is, from a designer's point of view, a *safe* one; the second is extremely risky. For this reason, the first method (Behn-Eschenburg's) has been called by Behrend the pessimistic one, and the second the optimistic one.

Either method is capable of giving good results when the field cores of the machine are well below saturation; but as saturation is approached, the divergence between the results of the two methods increases, the experimental results lying, as a rule, between those furnished by the two methods. On this account, Arnold and others have recommended the use of both methods, the mean value being taken as correct.

ANALYSIS OF FICTITIOUS ARMATURE FIELD INTO ITS COMPONENTS.

Better agreement with experiment is obtained by the use of methods in which the armature field is analysed into its components.

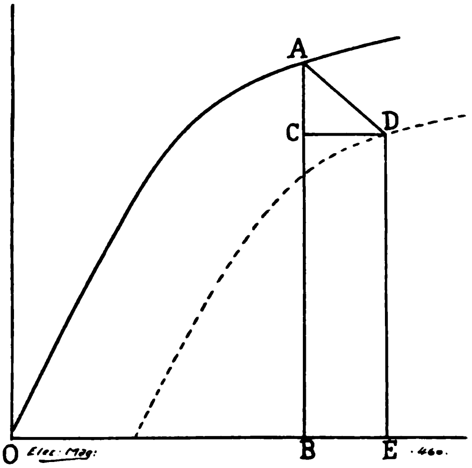


FIG. 18

A. Potier was the first to describe an experimental method for separating the leakage self-inductance from the effect due to the back-turns of the armature when loaded with a highly inductive load (so that the current may be regarded as practically in quadrature with the open-circuit E.M.F.) The cross-field in this case disappears, and the effect of the armature resistance drop may be neglected, since it is in quadrature with open-circuit E.M.F. Let (in Fig. 18) OA be the open-circuit characteristic. Take any point A on it, corresponding to the exciting current OB and the open-circuit E.M.F. BA. If the armature back-turns were non-existent, and armature leakage alone present, the P.D. would be given by BC = AB—AC, where AC = $l_s p$ I, l_s being the leakage self-inductance, and I the wattless current. Since, however, the armature gives rise to a definite number of back-turns, an equivalent number of ampere-turns must be added to the field in order to balance them if the P.D. is to be maintained at the value BC. This increase in the field ampere-turns corresponds to a certain increase in the exciting current, represented by BE in the diagram. By displacing BC through this distance, we obtain the point D; so that ED gives the P.D. corresponding to the exciting current OE when the armature current is I.

Let us now suppose that the reactance of the external circuit is varied in such a manner as to keep the armature current I constant while the exciting current is steadily increased. For the sake of brevity, we shall refer to the curve connecting exciting current with P.D. as the *wattless characteristic* corresponding to the given armature current I. It will now be evident that the wattless characteristic is obtained from the open-circuit one by displacing the latter parallel to itself in the direction of, and through the distance, AD. Assuming that the wattless characteristic, drawn as a dotted curve in Fig. 18, has been found *experimentally*, we may take a tracing of the open-current circuit curve and, having marked a certain point A on it, displace the tracing until the curve fits over the wattless characteristic, and then mark the displaced position D of the point A. We thus get the line AD, which may be resolved into the leakage self-inductance component AC and the back-turns component CD.

This method of separating armature leakage from armature reaction involves the experimental determination of the complete wattless characteristic for any convenient value of the armature current. Simplified methods of finding AD, AC and CD have been described by A. Blondel* and J. Fischer-Hinnen †; in these methods the observation of a *single* point on the wattless characteristic, in addition to the open and short-circuit curves, suffices for the separation of armature leakage from armature reaction.

It may be pointed out that the determination of either the complete wattless characteristic, or of a single point on it, does not involve the use of any large amount of power (since the current is wattless), and is easily carried out if a suitable variable reactance is available.

POTIER'S METHOD.

On the possibility of separating armature leakage from armature reaction, Potier has founded a method of deducing the load characteristics corresponding to various power-factors which, although more complicated, is capable of giving far more reliable results than either Behn-Eschenburg's or Rothert's method. To some extent it is a combination of these two methods.

The resultant exciting current is first obtained according to Rothert's method, the construction of Fig. 16 being employed, except that for the angle ϕ is substituted (which is more correct) the angle θ, by which the current lags behind the open-circuit E.M.F. Now ϕ (or rather $\cos\phi$) is given; but θ is, to begin with, unknown. The difference between ϕ and θ is not generally large, so that as a first approximation we may use ϕ instead of θ. The resultant current OA_r (Fig. 16) having been obtained, we refer to the open-circuit characteristic, and find the corresponding E.M.F. The latter is by Rothert taken to represent the P.D. Potier, however, goes a step further, and compounds this E.M.F., which is represented by the radius OD of the arc shown in Fig. 19, with the armature leakage E.M.F., $l_s\,p\,I$, represented by LO = DA; thus obtaining the P.D., OA. The construction shown in Fig. 19 also gives us the angle θ (approximately). We may now repeat the construction of Fig. 16, using, however, θ instead of ϕ, and then re-determine the P.D. by the construction of Fig. 19, thus getting a closer approximation.

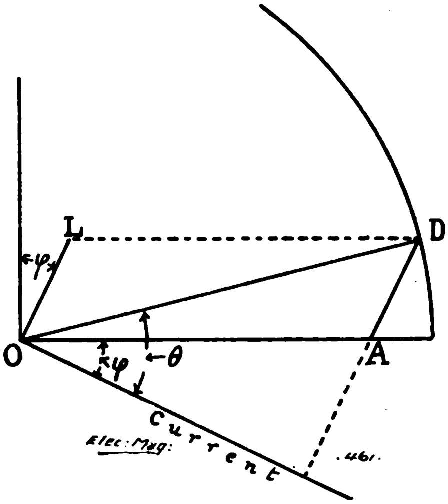


FIG. 19.

CONCLUDING REMARKS.

The above account of the more important methods hitherto employed for predetermining the behaviour of an alternator under varying conditions of load is not by any means exhaustive, but is intended as a brief summary of the very extensive literature of the subject. It is, unfortunately, the case that the amount of purely theoretical investigation which has been devoted to this subject is greatly in excess of accurate and thoroughly reliable experimental data; it being in most cases easier to propound a theory than to substantiate it by means of well-devised and carefully carried out experiments. Further real progress is probably to be looked for in a more elaborate *experimental* study of alternators, rather than in any startlingly new theoretical developments.

Alfred Hay

The succeeding issues of "The Electrical Magazine" should be closely followed for articles of a theoretical and practical nature. We have contributors in all parts of the world, and can draw upon universal experience.

---

[*] *Elektrotechnische Zeitschrift*, Vol. 22, p. 475.

[†] *Ibid*, Vol. 22, p. 1064.

ELECTRICITY APPLIED TO MINING AND METALLURGY.

V. Electrical Machinery in Steel Works (concluded).

By PERCY R. ALLEN, A.M.I.C.E.

(Concluded from page 480.)

At the last chapter the ingot was supposed to have arrived at the cogging mill ready to receive the first treatment of the rolls: it has already been explained that the function of the cogging or breaking down mill is to reduce the tapered ingot to a parallel section, and to elongate it and to put work into it by repeated passes so that the bloom or billet finally emerges in a shape consolidated and convenient to be dealt with by the finishing trains.

The power required for driving a cogging mill may be anything up to 10,000 h.p., and the operating conditions are most onerous. The maximum power is required for a few seconds, then all the work goes off and the direction of the rotation of the rolls must be at once reversed. The motive power usually employed to drive this mill is steam at a fairly high pressure, with either a compound or triple cylinder engine geared to the rolls without any flywheel, and depending simply on an ample supply of steam at the back of it. The mere suggestion that it might be possible to apply electric motors to driving heavy reversing mills would, a short time ago, have rather staggered the average electrician. However, the problem is now being studied and elucidated in Germany, and one firm, at least, of electrical engineers are even now prepared to build motors up to 9,000 h.p. for this purpose.

For several years past electric driving has been applied on the Continent for driving trains of rolls which run in the same direction, such as three high mills, the requisite steadiness of running being obtained by inserting a heavy flywheel somewhere between the motor and the rolls; a certain amount of elasticity being introduced to the system by the use of rope driving. This fairly equalises the demands on the motor without having to provide any special electrical arrangements.

Quite a number of motor-driven continuous running mills have been installed, and more are now being put up; for instance, there is a 300 h.p. sheet rolling mill at the Dillenger Hutte, a 600 h.p. Bar Mill at Burbach, a 500 h.p. mill at the Hedderheim Copper Works, and there are at present nearly completed, five large rolling mills, having motors which will have to exert from 1,000 to 1,800 h.p. each. Three of these mills will be erected at Gutehoffnungshutte and one at Friedenshutte, and the other at Peine, where there is already a 600 h.p. bar mill electrically driven, and at the Forges et Acieriet d'Anvers the Westinghouse Co. have installed some three phase motors of 325 h.p. for driving several trains of rolls, so that it may be assumed that any difficulty in driving mills of this class by electromotors has been pretty well overcome, but where the mill is of the two high type and has to be continually and rapidly reversed, much more severe conditions have to be met.

The requirements as to acceleration, retardation, stopping and starting, are somewhat similar to those existing in an electric winding installation, but in a rolling mill they are further complicated by variations in the heat and the plasticity of the ingot, and the matter is made more difficult by the suddenness with which the demand for the maximum power comes on. A cogging mill may be only taking one moment sufficient current to keep it turning round, and the next instant may have to put forth from 5,000 to 6,000 h.p., or even more, during the first pass of the ingot or slab; obviously the current to deal with this could not be drawn from any ordinary net work of mains. However, the case has been met in a very successful way by the use of the Ilgner system of flywheel converters, which has already been referred to in the first of these articles in connection with electric winding engines. This system provides for the

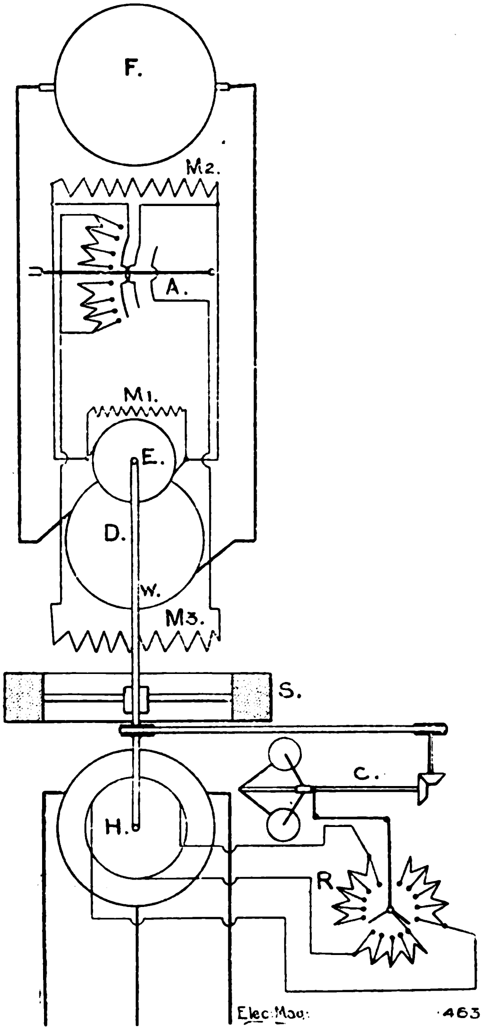


Fig. 1. Diagram of Ilgner System.

storing of a large amount of energy by means of a heavy quick-running flywheel attached to what is termed a rotary converter, but which is, in reality, an arrangement of motor generator, the motor side of which receives the current from the central station, using, probably, a high tension three-phase supply, while on the other side of the flywheel there is a continuous current generator feeding a continuous current motor driving the rolls. Fig. 1 shows, but unfortunately on rather a small scale, the general scheme of connections referred to. F is the rolling mill motor, which has to be reversed, and which is fed with current from D, the continuous current generator mounted on the same shaft as the motor H, which is in this case shown connected to a three-phase circuit; S is a cast steel flywheel, weighing between 20 and 30 tons, running at from 430 to 480 revolutions a minute. It is now proposed to make these flywheels up to 60 tons.

The magnet circuits of both the continuous current generator and the motor it supplies are excited by current from a small subsidiary machine marked E, and the regulation is effected by varying the strength of the magnet fields, and not by the introduction of any ohmic resistance into the main circuit; the diagram shows also a further means of regulation by the use of a centrifugal governor controlling resistances inserted in the rotor windings of the three-phase motor. It will be readily understood that a heavy flywheel running at this speed will store a large amount of energy, and act as a very effective screen against variations of voltage on the motor side of the combination; altogether this arrangement seems a very simple and elegant means of meeting very difficult conditions. Fig. 2 shows in plan an installation of the Ilgner system at the Eisen und Stahl Werke, Bethlen-Falva A.G., Schwientochlowitz. It will be seen that there are three lines, or, as the Germans call them, streets, of rolls driven by means of compound wound continuous current motors coupled direct on to the rolls, each train having a separate flywheel. The motor generator with the flywheel is shown at C, D and H. C is an alternate current induction motor working at 5,800 volts, and giving 600 h.p. at an average of about 375 r.p.m. D is a direct current generator coupled to the same shaft, and generating continuous current at 510 volts. H is the flywheel weighing 20 tons. The motor marked A drives the first line of rolls, is compound wound, 200 h.p. running at 60 to 110 r.p.m. at 500 volts pressure, and has a flywheel, F, weighing 12 tons, with rolls 17¾ inches in dia. The motor marked B is 200 h.p., runs at from 150 to 230 r.p.m., voltage 500, and flywheel G weighs 8 tons, the rolls being 13¾ inches dia. The motor E is 300 h.p. and runs at 390 to 460 r.p.m. In this case the flywheel, I, is 5 tons, and the diameter of rolls 10¼ inches. Fig. 3 shows a perspective view of this installation from the right hand corner, the motor E being prominent in the foreground.

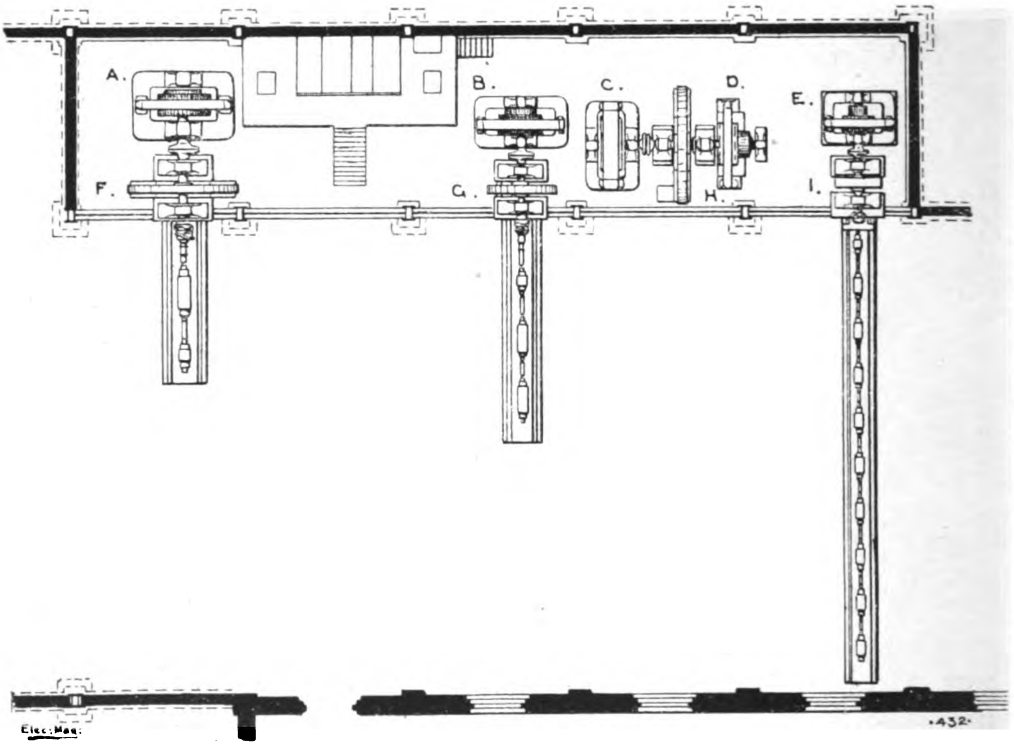


FIG. 2. PLAN OF ILGNER ROLLING MILL SYSTEM, ELECTRICALLY DRIVEN.

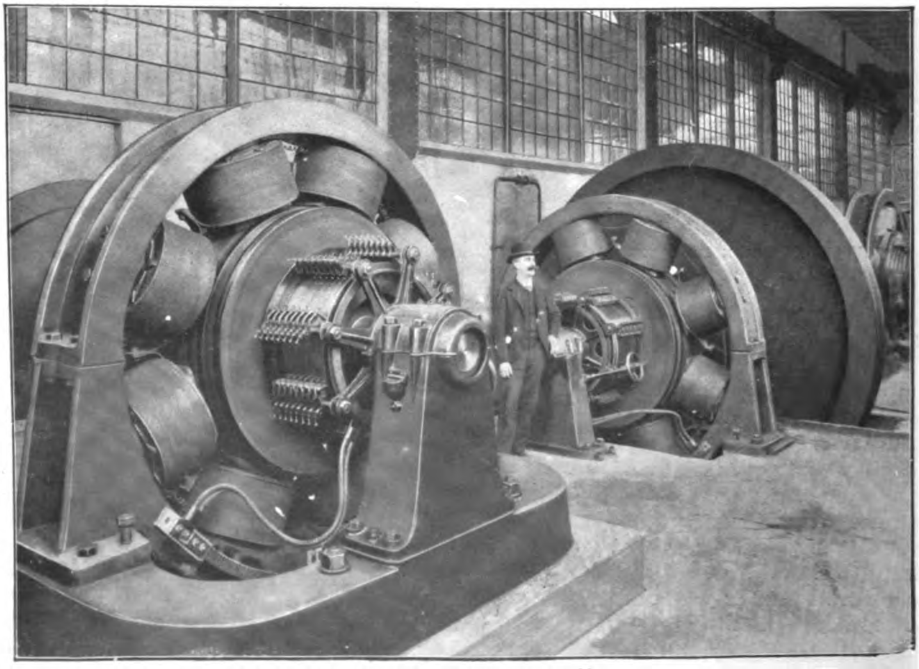
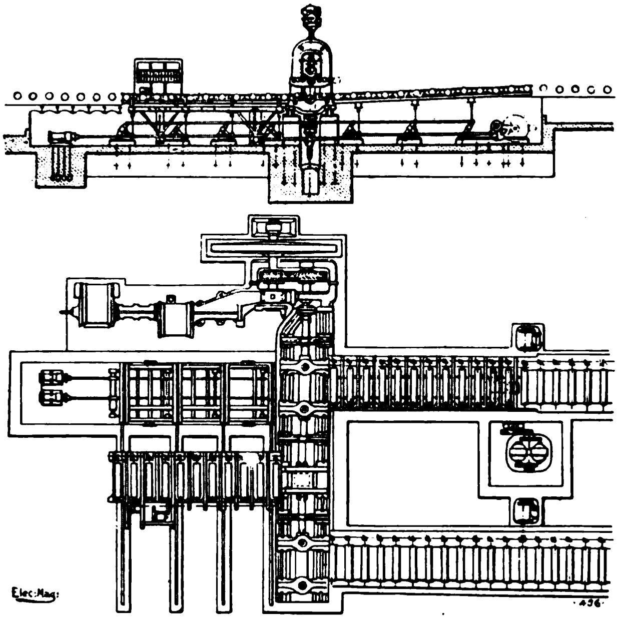


FIG. 3. VIEW OF ILGNER ROLLING MILL MOTORS.



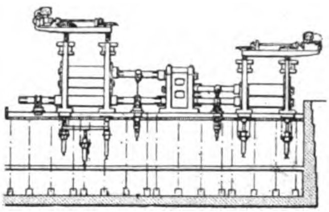


Fig. 4. Plan of Heavy Plate Mill·

while in the middle can be seen the continuous current generator D and the heavy flywheel H, while the motor B is seen in the extreme distance. The electrical part of this installation was furnished by the Allgemeine Elektrisitats Gesellschaft and the Union Elektrisitats Gesellschaft, and the writer is indebted to their representatives, The Electrical Co., Ltd., of London, for the description and the illustrations, and at the same time he has to thank Herr Carl Ilgner himself for further particulars.

The experiments carried out by Herr Carl Ilgner at Donnersmarckhutte in conjunction with various electrical firms, have been of great value in determining what can be done in the way of using really large motors for heavy intermittent work. For further information about this most interesting subject the reader is referred to *Stahl und Eisen*, of February 15th, 1904, where there is an exhaustive paper on electric driving in rolling mills by Chief Engineer Köttgen, of Berlin, and furthermore to an original article by Herr Carl Ilgner himself, entitled "Der Elektrische Antrieb von Reversier-Walzenstrassen," in No. 13 of *Stahl und Eisen*, 1903, and there is a further contribution to the subject in the same journal of May 1st of the current year.

The deductions to be drawn from these papers and the discussions they provoked are that if the gases from the blast furnaces and the coke ovens are utilised to the best advantage in gas driven central stations, there is a considerable positive economy in using electro-motors for even the heaviest work of a rolling mill, and all such economies are bound to have an important influence on the selling price of the finished article. At the same time it must be admitted that the introduction of the electro motor as a means of driving large rolling mills means such a displacement of steam driven plant that it is only the largest and most progressive concerns that care to face the change at present. But as an adjunct to existing rolling mills the electro-motor has already taken a prominent place, one favourite application being the use of small quick speed motors for the adjustment of the rolls, as by running a quick speed motor with high reduction gear and a suitable controller, the screws regulating the position of the rolls can be adjusted to the greatest nicety.

Fig. 4 shows, a heavy plate mill, built by the Junkerather Gewerkschaft, of Junkerath. In this arrangement, steam, hydraulic and electric power are all used for various purposes. The mill consists of a three high set of rolls 30 in. diameter, and 10 ft. wide, arranged on the Lauth system, and will produce plates from ingots of 6 tons weight. The other part of the mill consists of a two high set and is intended to make chequer plates. The motive power for driving the rolls, is a powerful compound steam engine. The tilting tables necessary to deliver and receive the plate at the top rolls of the three high side are raised and lowered by means

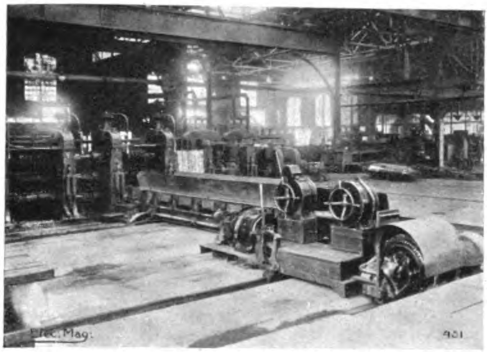


FIG. 5. ELECTRIC TRANSFER CAR.

of a system of bell cranks, connected to a toothed segment geared to an electro motor, and are regulated by means of hydraulic cylinders. At the front of the mill there is an electric transfer carriage, which, when the plate is finished by the three high mill, conveys it across to the other rolls to have the chequers impressed in it. The upper rolls are balanced by an arrangement of hydraulic cylinders, but adjustments to the top rolls are obtained by means of electro-motors working the screws through bevel gear. All the live rolls are electrically driven, and there are no less than 7 electro-motors used in this mill for various purposes.

The convenience of electric driving is very noticeable in this instance in its application to the transfer car, which, by the use of two motors, one for the live rolls and the other for the traversing motion, is enabled to be made self-contained, and runs on and off the tilting table like a locomotive, without having to resort to any complicated arrangements of chain gears or square shafts. It is difficult to imagine any other arrangement of gearing which would attain the same end in such a simple and elegant manner.

These transfer cars, or mill tables, as they are sometimes termed in Germany, are coming into considerable use on the Continent. Thin sheets or long flexible profiles can be rapidly and easily transferred from one set of rolls to another by these, instead of sprawling over the floor. Fig. 5 shows one of these machines made by Messrs. Kolben, of Prague, and installed in connection with a three roll high finishing mill rolling profiles: the table has a tilting arrangement besides longitudinal traversing, and while the latter movement is obtained by electro-motors driving direct-

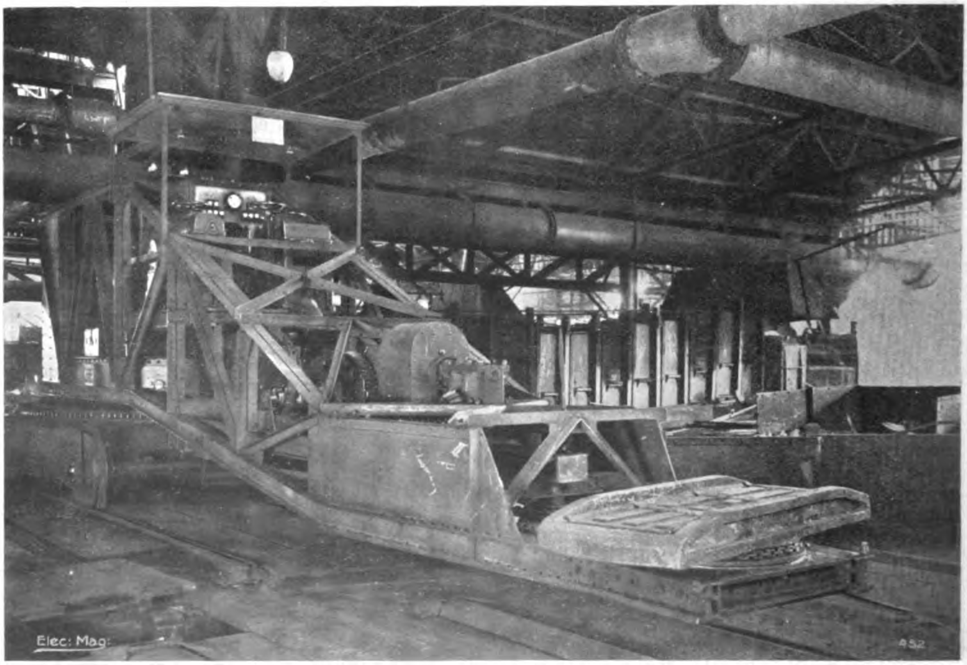


FIG. 6. ELECTRIC FURNACE CHARGING MACHINE.

the tilting action is controlled by a hydraulic arrangement worked from an accumulator in which the pressure is maintained constant by a pump driven by an electro-motor which automatically stops and starts as the pressure rises or falls.

It has been explained, that after the bloom comes from the cogging mill, and has been sheared square, it is generally put back into a re-heating furnace prior to further treatment. Several different arrangements of machines for handling these blooms are to be met with, some of them running on rails on the floor level, and others being suspended from overhead. The blooms have to be taken hold of by some sort of tongs, which in many cases are made capable of causing the bloom to rotate on its axis. Fig. 6 shows a very elaborate furnace charging machine in use at the Peine Rolling Mills, of which the electrical portion was furnished by Messrs. the Siemens Schuckert Werke, from whom the writer obtained this illustration. The machine will be seen to consist of a substantial truck carrying a turntable, from which projects a long built up arm, which at the outer end has another turntable or plate which can be revolved by means of a chain connection to an electro-motor. At the rear of the revolving plate will be seen the head of a ram which is also worked by an electro-motor, and when the hot block is placed on the small turntable, the whole machine is run along to the rolls, where the bloom is pushed off by the movement of the ram. All the movements, including the revolving of the main turntable and the travelling of the carriage, are operated by continuous current series wound motors capable of being reversed and manipulated by means of controllers placed in a cabin above the projecting arm.

The hot saws for reducing the finished sections to approximate lengths after leaving the finishing rolls are in modern works generally driven by electro-motors, the pendulum type being usually adopted for small profiles, such as rails, angles, channels and light joists, while somewhat different designs are used when dealing with heavier sections. Fig. 7 shows a combination of four pendulum saws, serving a finishing mill with 35½ in. rolls, installed by Messrs. Haniel & Lueg, of Dusseldorf, at the rolling mills belonging to the Union Company of Dortmund. It will be seen that separate motors are mounted on independent foundations behind each machine, and drive by means of belts up to a pulley mounted on a shaft which serves as the axis of the pendulum frame carrying the saw at the bottom end, the saw itself being driven by a pair of belts, one on each side; as will be readily understood, this arrangement maintains a uniform tension on all the belts whatever the position of the pendulum may be. A close examination of the picture will show that the swinging motion of the pendulum and feed of the saw is controlled by a pair of small hydraulic cylinders acting through a rack and pinion motion: this gives a very steady and powerful feed, and counter-

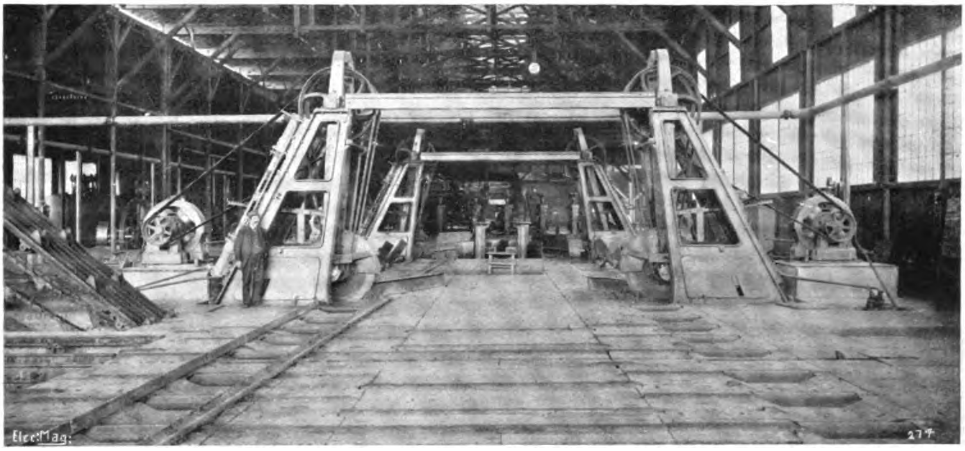


FIG. 7. ELECTRICALLY DRIVEN PENDULUM HOT SAWS.

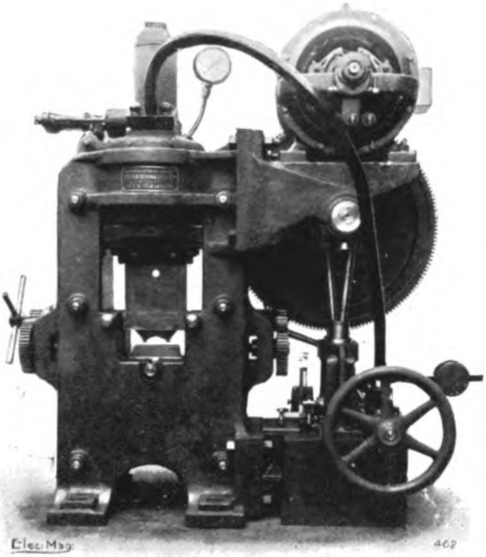


Fig. 8. Electro-Hydraulic Cold Shears.

acts the tendency of the saw to dig in and jam in the hot metal. This is another example where the electro-motor is best adapted for one purpose, and hydraulic power for another. Referring to the picture again, there will be seen on the right hand side, just in front of the live roll, the lug of one of the skid chains projecting out through the floor. These skid chains have already been referred to before, as being one of the means of conveying the finished or semi-finished sections across the mill, the live rolls providing longitudinal movements; the skid chains are driven by electro motors, controlled from pulpits or raised stages in convenient positions. On the extreme left of the picture, may be seen a combination of skid chains working an inclined elevator. Hot saws for dealing with larger sections, and taking saws 60 in. and upwards, are generally provided with two motors, one to drive the saw itself, and the other to work a powerful screw feed with a quick return motion. In this arrangement, the screw is overhung at the end of a sliding carriage, which can be caused to move in and out of a heavy base, something like the ram of a shaping machine. A very neat design of large hot saw, is built by the Benrather Maschinenfabrik, of Benrath bei Dusseldorf. In this case, the two motors are mounted at one end of an oscillating beam which carries the saw at the other end, and the downward feed is obtained by means of a worm and worm wheel, driving a crank attached to a connecting rod, the bottom end of which is anchored to the frame.

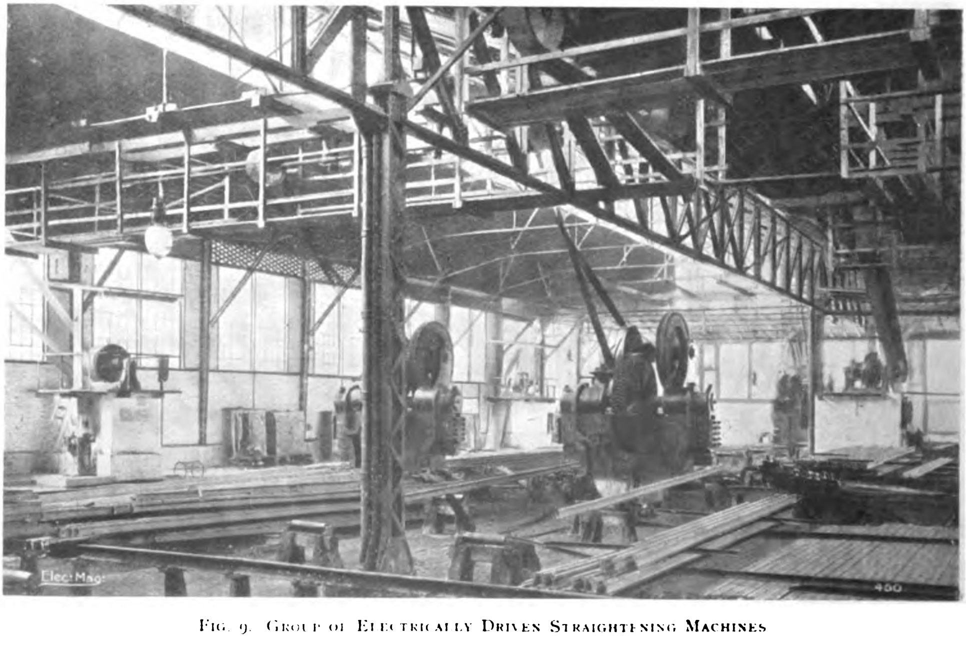


Fig. 9. Group of Electrically Driven Straightening Machines

When the sections have cooled off on the hot banks they have to be removed, cut to dead lengths, and straightened, and if necessary, punched or drilled. Cold shears are undoubtedly the most rapid way of cutting ordinary sections to exact dimensions, and Fig. 8 shows an interesting machine built by Messrs. Breuer, Schumacher & Co., A.G., of Kalk, near Cologne. These machines are built in the larger sizes to operate on symmetrical sections, such as joists and H irons up to 7¾ in. × 19½ in. It will be noticed, that the moveable shear blade is of peculiar outline, and passes between fixed blades on each side, thus giving a clean square cut. The arrangement is interesting from an electrical point of view, because the hydraulic ram holding the shear blades is actuated by a pair of pumps worked by an electromotor. Both plungers work up to a certain pressure, then one of the suction valves is automatically switched out, and the higher pressures attained by one plunger alone. The shear is lifted up on the return stroke by a small subsidiary cylinder above the large one giving the cut. The duration of the cut takes from 27 to 100 seconds, depending on the size of machine and dimensions of section, and in the larger sizes the motor has to exert 25 h.p. Usually, a steam intensifier would be used for an operation of this kind, and the use of an electric motor for this purpose is illustrative of the general inclination to use electric transmission wherever it can be profitably employed.

The straightening machines shown in Fig. 9 represent a group at the Rheinische Stahlwerke, of Meidrich, bei Ruhrort, the electrical installation being supplied by Messrs. Siemens Schuckert Werke. It will be noticed that the motors are belted up to the presses through overhead counter shafting. The presses themselves are of usual construction resembling the ordinary pattern of punching and shear-machines. Incidentally it may be remarked that all these slow moving tools seem to consume an enormous amount of power when running light. Some electric shears tested by the writer in Belgium took 28 h.p. when running light, and only 34 h.p. when shearing a heavy plate. The value of the coefficient of friction of large surfaces at slow speeds is not quite such a simple matter as text books would suggest.

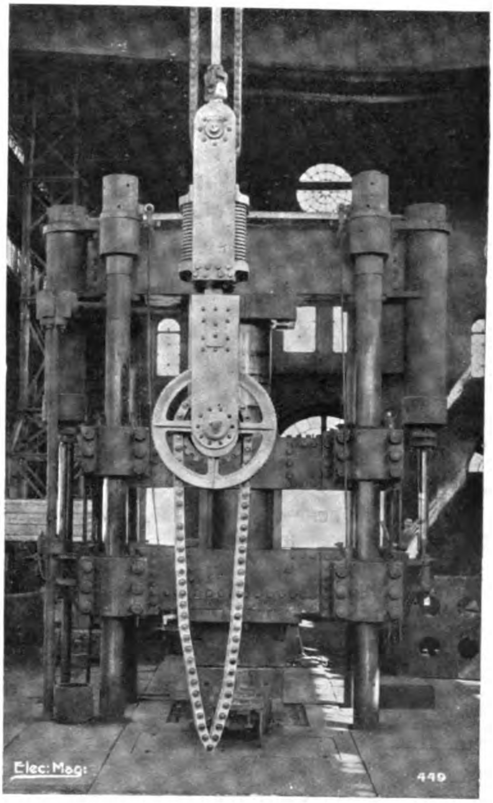


Fig. 10. Electric Sling for Heavy Forgings.

A very convenient application of the electro motor is in use at the John Cockerill Works at Seraing for manipulating heavy forgings under the hydraulic press. The ingot or piece being worked generally has a long shaft welded on or drawn out for the purpose of handling while being worked. This is slung in pitch chain, and by turning the chain the forging can be more or less rotated. To do this by hand is a very slow and unsatisfactory performance, and while compressed air and hydraulic arrangements are now frequently used they have not the convenience of the electric motor. The device shown in Fig. 10, was designed and built by the International Society of Liege, for the works at Seraing. The turning gear is suspended from the crab of an overhead traveller by double chains, and the turning is effected by a 6 b.h.p. continuous current motor which communicates by means of an universally jointed and telescopic rod with a sprocket

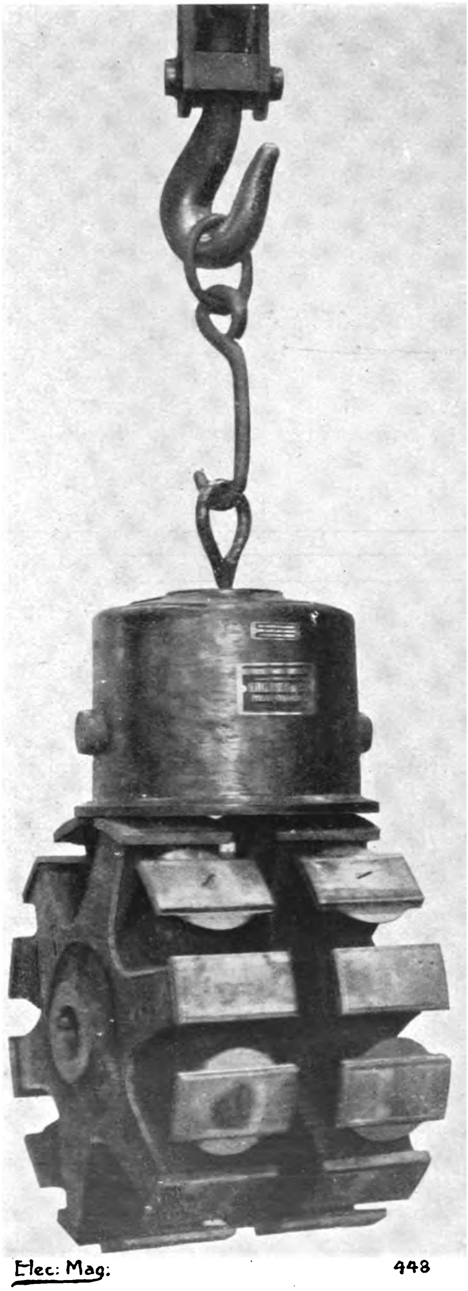


FIG. 11. ELECTRIC LIFTING MAGNET.

wheel engaged with porter bar turning chain, the turning arrangement being hung on a powerful quadruple spring to take up shocks. The writer has seen this at work, and can testify to its convenience and utility. There is no side strain on the turning chain, and no slack to take up when the motor is reversed.

The last illustration (Fig. 11) shows rather appropriately a lifting magnet with the rotor of a dynamo weighing 2,000 kilos suspended from it. These electro magnets for lifting purposes are now coming into very extensive use in stock yards, and for the handling of plates, joists, etc., in constructional work, a very considerable saving of time is effected by their use, as the magnet simply attaches itself to the piece to be lifted without any slings or heavy chains. If proper care is taken that the supply of current is not interrupted, these magnets may be fairly well relied on, although it is just as well not to walk underneath them.

Space has not permitted the consideration of electrical furnaces, and as yet these must be regarded as being in the experimental stage, although the results lately obtained in Canada go to prove that their commercial application is merely a question of cost of power. Probably when they do come, their first applications will be in the production of high class tool steel or steel alloys and in the reduction of metallic sands which are often found where fuel is scarce but water power happens to be plentiful, as for instance, in certain parts of Norway.

In the present series of articles, the writer has only attempted to treat in a very general way some of the most important applications of electric transmission in Continental mines and metallurgical works, and it must not be considered that because the description has been confined to the Continent of Europe, the writer has wished to ignore or under-rate the capabilities of English or American firms to build machinery to do the same range of work. The electrical engineer is doubtless ready and willing enough, but the capitalist and the coal proprietor and the iron-master seem hardly to realise how far the use of electric power may be enlisted to cheapen the cost of production. Herr. F. W. Lurrmann, a well-known German authority, estimates, in connection with the Antwerp Steel Works, that by utilising the gas from the blast furnaces, the cost of pig iron would be reduced 6 fr. 88 c. per ton. It may be mentioned, that when these works at Antwerp are completed, they will, after supplying the requirements of their own works, have sufficient surplus current to do most of the lighting and traction required by the municipality of the town.

No doubt the wider application of electricity is only one factor amongst many which have aided in the wonderful expansion of the mineral and metallurgical industries in Germany, Belgium, and the adjoining countries during the past decade; there are of course many contributive causes,—a protective tariff, lower wages, more advantageous railway rates, the co-operative assistance of the various cartels or trade associations, and to a certain extent the practice of dumping abroad, while maintaining the home market. All have more or less contributed, but in the opinion of the writer, the most important element has been the singular enterprise shown by the Germans in modernising their works and their readiness to consider new processes, come from where they may.

The writer was last year at one of the most successful iron and steel works in North Germany, where a large amount of money had been lately spent in installing a complete electrical equipment driven by blast furnace gas, although the steam driven plant was almost as good as new. It should be explained that this concern had paid 42% dividend for the previous year, and when it was remarked to the managing director that it was possible for the Company to put down such an up-to-date plant, as they paid such handsome dividends, the immediate answer was:—"No, we are able to pay 42% because we put in modern plant; we have to lead to live." The case of Germany has been referred to as an example, but the same spirit of judicious enterprise is manifested in France, Belgium. Luxembourg, and Austria Hungary.

Last year, for the first time on record, the production of pig iron in Germany surpassed that of Great Britain, and there is no doubt the competition will become increasingly severe, and in the present state of the public opinion it would seem that such competitions would have to be met by brains and not tariff. There can be no doubt that, if a wider knowledge of what is being done abroad in the development of electric power in mining work and steel manufacture, and the saving effected thereby was brought home to the capitalist in this country, he would be favourably inclined to consider the remodelling of many English works, which at present hardly pay, and a great deal of employment found for the manufacturing electricians.

In Germany, most of the large electrical firms have established departments dealing with mining work and steel work plant, and the subject is carefully studied, and vigorously pushed commercially. In conclusion the writer must express his sincere thanks to his numerous friends on the Continent, who have so kindly furnished him with descriptions, photographs and explanations, and given facilities for visiting so many interesting works. It is a little to be feared that the readiness with which the English engineer is shown over the large works abroad is not always reciprocated in this country, and one should not forget the splendid hospitality shown to our various Institutions on the occasion of the Dusseldorf Exhibition.

Percy R Allen

Important Notice.

The series of articles by Mr. P. R. Allen, above concluded, has given some details of Continental Electric Practice in Mining and Metallurgy. We shall hope to present to our readers in subsequent issues the aspect of the same question from British and American standpoints, thereby covering the whole known ground, in countries recognised as in the front rank of industrial progress. To this end we are making special arrangements with engineers qualified to handle the subject from an impartial standpoint, so that the real facts may be presented in the same unprejudiced manner characteristic of Mr. Allen's series.

THE INDIVIDUAL MOTOR DRIVE.

By ROBERT T. LOZIER, M.A.I.E.E.

[*This article is the first of a number, which will appear from time to time, from the pens of influential American writers.*—ED.]

THE practical development of the individual motor drive, that is now receiving so much attention, may be said to have begun—in America—about eight years ago. It was thought at that time that the general convenience gained by doing away with belts, and the saving in the power lost in transmission, were sufficient incentives to make this new practice general. It hardly seems possible that this could have been realised. The cost of power in the average industrial establishment may be taken, as a rule, to represent not more than 2% of the billing price of that establishment's output. And while it was found that the individual motor drive could easily cut down the power required by one half that required by the mechanical system, both for transmission and for the useful work, also that its convenience was undeniable, yet these factors alone did not seem to warrant, in every day practice, the relatively large investment required for the individual motor application.

But, at this same time, important developments were being made in general shop practice. One of the most radical of these was the discovery of the air-hardened cutting steel, which could displace two, three, and, in some cases, four times the metal that was cut off by the tool steels operating under the old conditions. These heavy cuts required a proportionately increased power and the higher speeds, greater ranges, with far more increments. The old shafting and belting systems were not adequate for these new purposes. The cone pulley had, as a rule, but seven changes, badly proportioned, and it was not possible to obtain the range without redesigning the tool. The belts slipped and would not stand up to their work. The strains put on the shafting increased the losses, and in some cases pulled down the counter-shafting. So it was found that if these tools were to be worked up to the new standards established, the existing power transmissions and systems of control were entirely inadequate. These could be stiffened up and readjusted, but the power losses would be considerable, and the mechanical speed control was not as flexible or convenient as demanded. With the electric drive the controller handle comes directly under the hand of the operator, who can select, while the tool is cutting, any one of fifteen or twenty different speeds at will. Then the advantages that first suggested the individual motor came in for consideration: *viz.*, that absence of belts gave free head-room for overhead crane service, and resulted in improved light and ventilation; that a shop's structure could be much lighter if it had not to support heavy lines of shafting. Another point of interest was, that with individually driven tools their arrangement was more convenient than if they were obliged to follow fixed

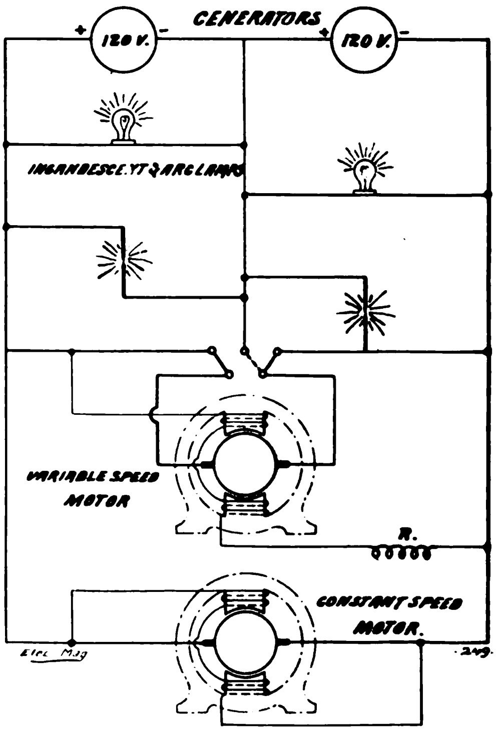
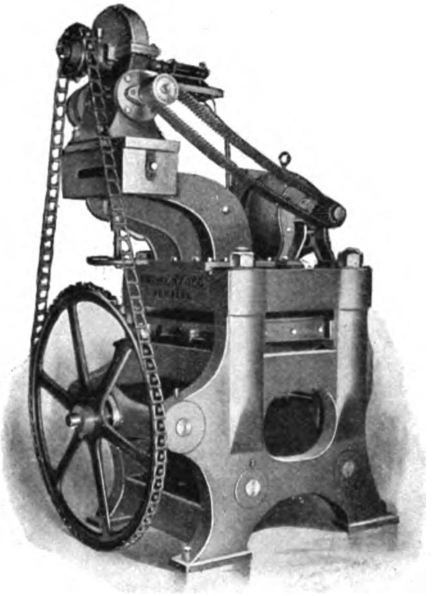


DIAGRAM OF THREE-WIRE SYSTEM.



Motor Driving Electrotyping Press.

lines of shafting, so that in a shop so driven the tools occupied 20% less space. The saving in power transmission also permitted of a reduction in the power plant.

It is to be pointed out that the most important gain that has induced the principal industrial establishments of America to equip their new shops with electric drive, and, in many cases, to change over their old shops, is the increase possible in the output. One of the largest of these establishments, in making a comparison between an existing old shop driven by shafting and their new shop equipped entirely with individual motors, states the increase in output credited to the individual motor is 30%.

Let us see how this figures out:

Assume a shop has a billed output of	£200,000
That the cost of power by mechanical transmission is 2% thereof, or ...	4,000
That the cost of power by individual electric drive is 1% thereof, or ...	2,000
That the additional investment required by the motor drive is ...	6,000
Then it would take three years for the motor drive to pay back the investment.	
Now assume the increase in the factory's annual billed output, due to the individual motor drive, to be but 10%, or	20,000
That the extra material and other expenditures involved in that increase represents one half thereof, we then have a yearly return to the manufacturer on his investment for the motor drive of	10,000

And it has been this latter practice that has attracted the manufacturer and is responsible for the rapid development of this branch of the art. The gain varies with each case, and the conditions prevailing in the shop will determine the extent to which the individual motors can be applied.

From the foregoing it will be seen that the tools in a shop readily come within two general classifications, which are given below with their sub-divisions:

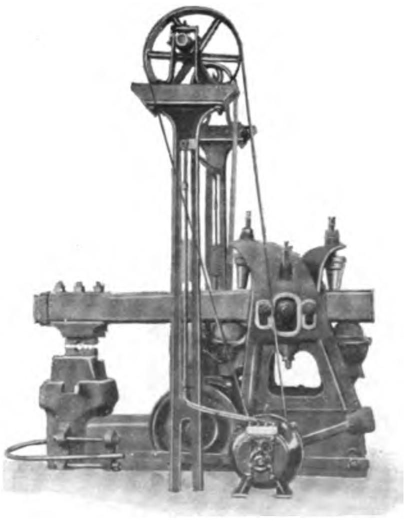
1. TOOLS WHICH WARRANT THE INVESTMENT FOR INDIVIDUAL MOTORS.

(a) Those in which it is desired to vary the speed, and to have a source of power that will stand up to the work put upon it.

(b) Those in which the convenience gained by the individual motors, permitting of a clear space for the overhead crane to work in, with resulting improvement in light and ventilation, and those tools that cannot otherwise be conveniently reached by line shafts and belts.

2. TOOLS WHICH DO NOT WARRANT THE INVESTMENT FOR AN INDIVIDUAL MOTOR.

These tools are those that run at fixed speeds not often varied, and which occupy that part of the shop where a clear head-room is not necessary, and the other advantages of convenience, etc., do not warrant the invest-

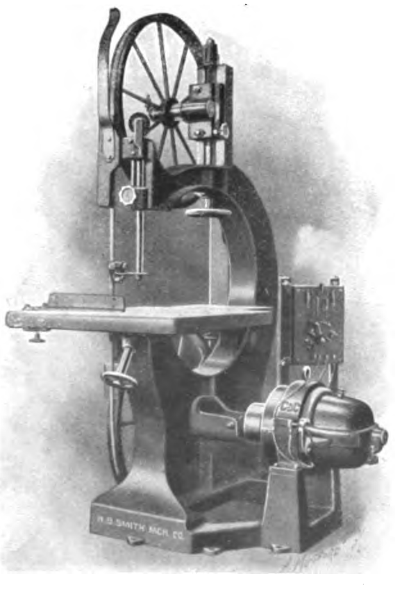


Motor Driving Hammer.

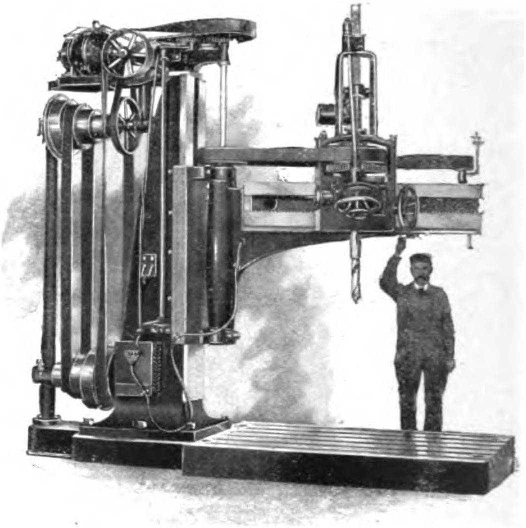
ment involved, and thus can be driven in groups.

Now, having determined which of the tools are to have individual motor drives, it is perhaps interesting to know how to choose the motors. The first thing to settle upon is the speed range to be employed and the method of obtaining it. For this purpose direct current motors are desirable, because their speeds are easily varied, while that of the alternating current motors are not. Under the old methods, the tool builder sent out his machine with a mechanical drive limited, as to its power and flexibility, to conditions established by practice many years back. Under the new conditions, the driving of the tool is adapted directly to the class of work which that particular tool is expected to do. It is a fact that to-day the tool builders find their past standards are entirely inapplicable, and are asking the purchasers of these tools to state what is required, so it becomes necessary to have some rules to be governed by.

The rotary machine tools may be said to represent the limits of speed variation, and the following general rule applying thereto can be stated: The *minimum speed* of a rotary machine tool is determined by the hardest material to be machined, and taking a cut of the largest diameter that the dimensions of the tool permit. The *maximum speed* is determined by the softest material, and the smallest diameter at which the tool will work efficiently.



Motor Coupled to Band Saw.

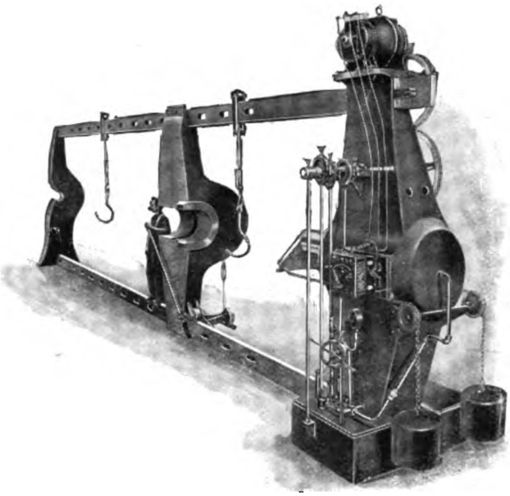


Motor Geared to 6 ft. Radial Drill.

Let us take a 26 in. lathe for example: If we turn a high carbon steel, 26 in. in diameter, at a cutting rate of 12½ ft. a minute, we will run the face-plate or spindle at 1·8 r.p.m. This will be carried on a double set of back gears, each having a ratio of 5 to 1, or a combined ratio of 25 to 1; the driving shaft of the lathe must turn at 45 r.p.m., which represents its minimum limit. If this same lathe is to turn soft iron down as small as 2 in. in diameter, and at a cutting rate of 120 ft. a minute, we have a face-plate or spindle speed of 230 r.p.m., and, as the back gears are out, the driving shaft of the lathe runs at 230 r.p.m., which represents its maximum limit.

This establishes a speed ratio for the driving shaft of the lathe of 5 to 1.

We have now found the speed limits of general machine shop practice, and they will cover any conditions that are likely to arise. When the work in a shop is so distributed amongst the tools as to permit of each doing its particular work, only one —or even both—back gears may be eliminated, and the speed range of the motor will then provide for such variations as may arise in (a) the material machined;



Motor Geared to 100 ton Hydraulic Press

(b) the cutting tool; (c) the diameter turned. The motor may be geared to the tool at 12 to 1; so that we have determined the speed of the motor to be, for this tool: minimum, 250 r.p.m.; maximum, 1,250 r.p.m.

Now to select the best method for obtaining that variation of speed in the motor. A combination of two methods is now generally accepted in best practice for this purpose, *viz:*

(a) Lowering the voltage at the armature terminals to reduce the speed below the normal of the motor.

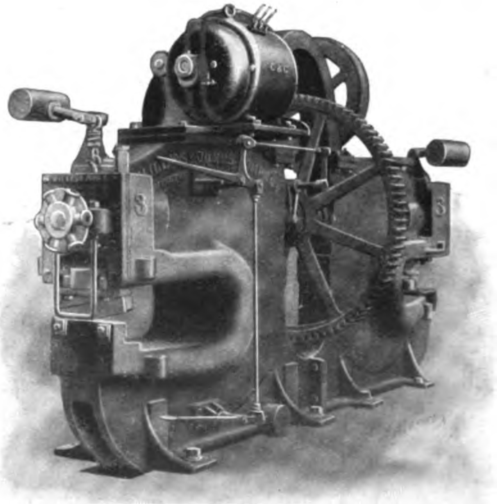
(b) Weakening the field of the motor to increase its speed above the normal.

Resistances are not necessary or desirable to obtain the lower voltages. Our reason is, that when used, the speed of the motor is unstable. The modern practice is to generate and distribute the electric power at two voltages. For this purpose the standard three-wire system now in general use is most excellent, having 240 volts between the outside wires and 120 volts to the neutral; the motor's armatures being connected across the neutral for the low speed range, and across the two outside wires for the high speed range.

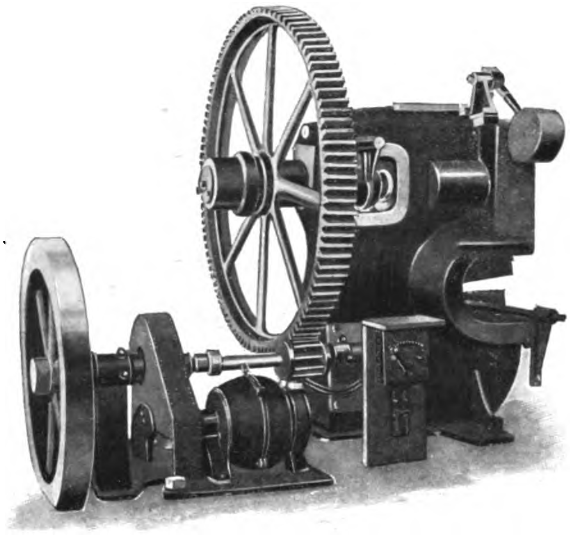
If the motor runs normally at 500 r.p.m. with full field strength and its armature across 240 volts, it will run at 250 r.p.m. when its armature is across 120 volts. Now, under the last conditions, if we weaken its field we can speed the motor up to 500 r.p.m., when we can again put it across the 240 volts and strengthen its field to saturation, and still have 500 r.p.m. From this point we again weaken its field, until 1,250 r.p.m. is reached, which represents the outside limits required.

It is true, that before the advent of a motor that would permit of its speed being increased 250% by field weakening, that it was necessary to use special multi-voltage systems of distribution, consisting of three (and sometimes four) wires, carrying voltages sufficiently low to reach the minimum limits of the range, and thus permit of the motor running normally, with full field strength, at a speed near enough to the maximum limit of the range to reach it by its field control. Such motors could not increase their speed more than 100% by field weakening without sparking, while—as stated above—motors are now available in which it is possible to increase the speed 250%, and still have as compact and economical a motor. If a three-wire system is not available and a speed ratio of 5 to 1 is desired, then the variable speed motor is provided with one change gear, or its armature body has two independent windings, which may be thrown in series or parallel corresponding to the 120 and 240 volts of the balanced three-wire systems respectively.

The methods just described are convenient. The three-wire system is already in general use, and lends itself most effi-



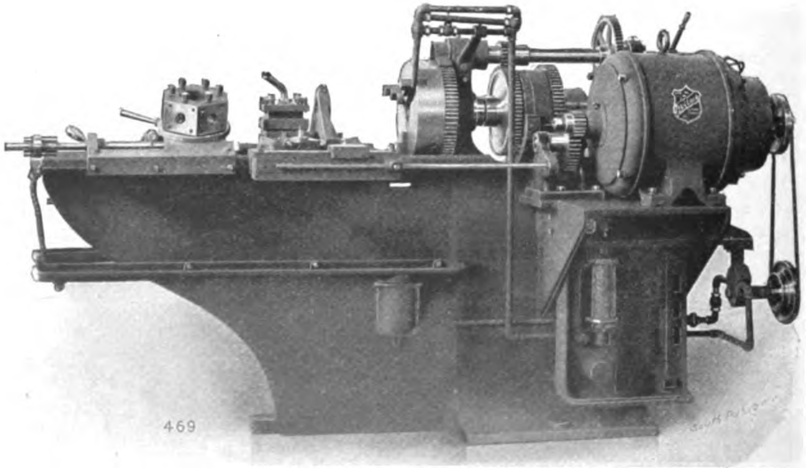
Motor Driving Shears and Punch.



Motor Geared to Shears.

ciently to a plant requiring both variable and constant speed motors, incandescent and arc lighting. The motor itself has been developed to a point where its efficiency is high and its depreciation low, and is thoroughly serviceable.

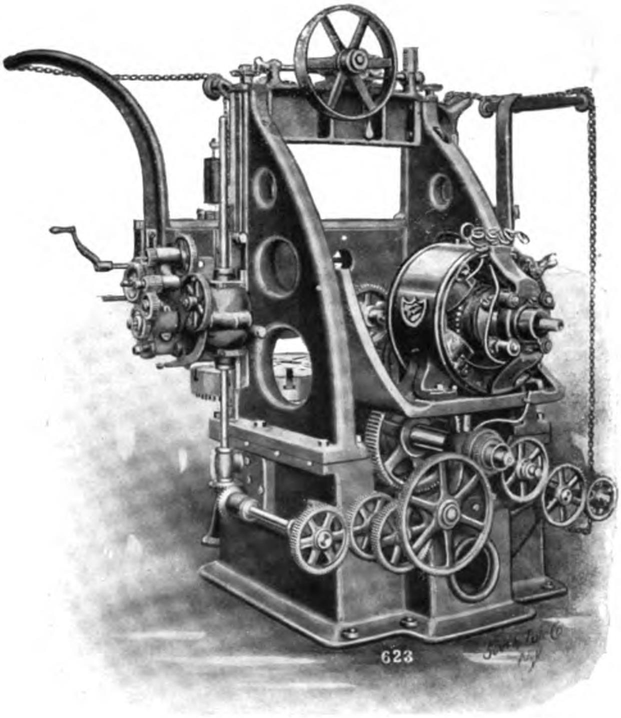
Now as to the power required to drive a tool. This must be determined for each tool and the material it is to handle, because the greatest part of the power delivered to the driving shaft of the tool may be, and often is, lost in moving the parts of the tool, for which no general rule can be laid down. I, therefore, do not place reliance in the rough rule that "1 h.p. will remove a cubic inch of soft steel in a minute, and the average efficiency of the tool is not more than 40%." The only true way to determine the horse-power required is to first actually run the tool by a motor, and take the readings under all conditions of service. It must be well remembered that if the motor's armature is running on half voltage, its capacity is reduced one half, and that increasing its speed by weakening its field reduces its torque; so that in figuring spindle (or face-plate) speeds, it must be taken into account whether the same are obtained by means of mechanical gearing in the tool itself or by motor control. The surest and simplest method, therefore, is the impirical one above stated. As to applying the motors to the tools, the common method employed is to take a standard motor, mount it on a convenient bracket or base, and either gear it to the driving shaft of the machine or drive it by a chain. An English device for this latter purpose is now largely used in America. The foregoing method is in contra-dis-



Motor Direct Coupled to Lathe.

tinction to building the motor into the tool, which has now been abandoned. The former makes it far more simple for the tool builder as well as for the user. Generally the number of sizes of motors used in an installation is restricted, even at the expense of sometimes using at larger motor than is actually necessary, but which permits of renewal parts being kept on hand in not too large a variety.

As to the extent that these motors are being introduced, this is increasing rapidly. Statistics and reports from manufacturers show that there are in America 300 concerns manufacturing metal making machinery, and that 30% of their product is now equipped with individual motors. One of the largest of these manufacturers states that, of the big tools, such as boring mills, vertical shapers, etc., 100% are electrically driven, and of his smaller product 33% are so driven.



Motor Driven Boring Mill.

This subject is susceptible of much elaboration; there are many things of interest to discuss, but space does not here permit. The information herein given is based on personal experience, and data to be found in the transactions of the Society of Mechanical Engineers and the American Institute of Electrical Engineers.

Robert T. Lozier

MANUFACTURERS ARE INVITED to give their views on the important questions raised in the above article. The subject of individual and group driving of machine tools has long been a vexed one, and Mr. R. T. Lozier—whose opinion we reproduce above—makes out a good case for the former. A matter of such vital consequence to manufacturers cannot be lightly passed over, and we invite bona-fide opinions from users of electric power as to the merits or otherwise of the author's ideas as above expressed.

POWER: and·its·application·to· INDUSTRY

The generation, transmission, and application of electrical energy, more particularly in its relation to industrial work and progress, will be specifically dealt with in this section. In this connection, research, investigations, new developments, modifications to existing systems, descriptive illustrated notices of power work at home and abroad, together with interesting and valuable notes from all sources, will be presented.

A Small British Water Power Plant.

By W. E. RUSSELL, A.I.E.E.

[In our March issue we drew attention to the comparative paucity of hydro-electric plants in the British Isles, urging that steps be taken to utilise even low falls where existing, for dynamo driving. Our remarks called forth a communication from Mr. W. E. Russell, whose article below describes a small plant operating in Yorkshire.—Ed.]

THE production of electric power from water turbo-dynamos, as was pointed out in the March issue of this journal, has not been developed to any extent in these islands, for obvious reasons. Unlike our American and Continental neighbours, we cannot boast of large falls, nor even of rivers of a size permitting of their employment for the operation of water turbines. Still, there exist opportunities for the installation of small units provided the problem is entered upon in the right spirit, and that reasonable support be given to engineers projecting such an enterprise. The author has been responsible for the laying down of a hydro-electric plant at Oates-Royd Mills, Luddenden, Yorkshire, the property of J. Murgatroyd & Sons, and a description of the work, with some account of the difficulties overcome, may prove of interest. The plant has been installed in sections, as the client needed some persuasion as to its efficiency, and deemed prudence advisable at the outset. This naturally introduced difficulties in addition to which the following may also be enumerated:

Provision for extensions.
Distance of water supply from mill (300 yds.).
Temperature of the water (90° F.).
Batteries placed at the mill and generators at the river.
The entire plant to be automatic.

The problem was also an unique one in that no precedent of such an automatic water plant was established at the time, 3½ years ago, when the first unit was laid down. This comprised a 32 B.H.P. Girard horizontal turbine, direct coupled to a 19 kw. generator. In conjunction was a battery of chloride accumulators, 400 a.h. capacity, and about 200 lights.

The entire plant, as now extended, consists of three units, the two additional to that mentioned above being installed later. By reason of the conditions governing the water supply, the plant has been installed in two separate power houses. Fig. 1 depicts the interior of No. 1 house, in which all three generators are placed, and of these the end ones are direct connected to their respective turbines, the centre one being belt driven from a turbine fixed in an adjoining building, as will be described later. This first plant derives its water from two sources; (1) the mill furnished with electricity is driven by three steam engines, and the surplus condensing water, collected in a 2,600 gallon tank, is delivered to the power-house, 190 ft. below, through 12 in. c.i. pipes, the flow equals 120 cubic feet per min. in winter,

PRIVATE HOUSE SUPPLIED FROM SMALL PLANT.

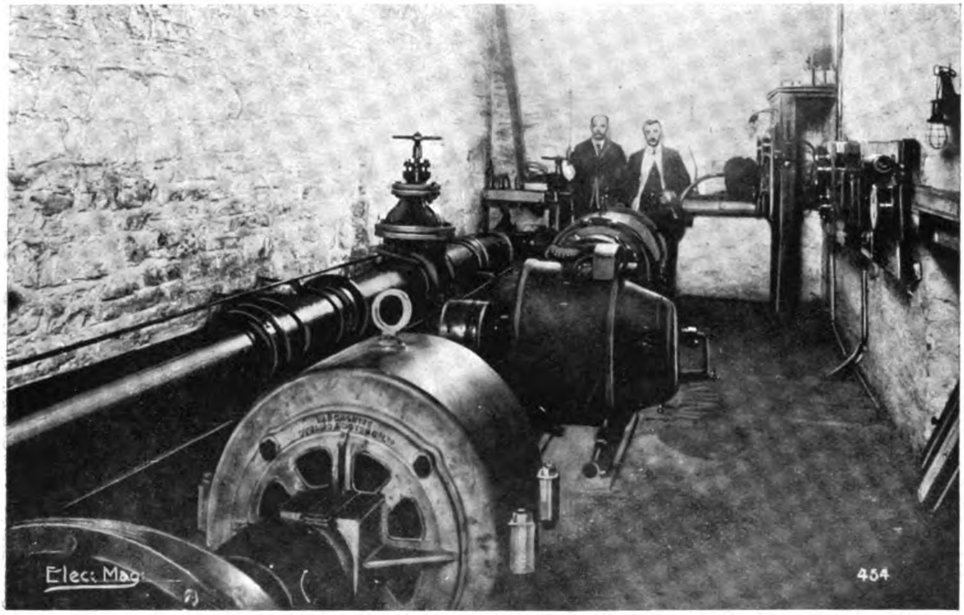


FIG. 1. INTERIOR POWER HOUSE NO. 1.

and 20 c.ft. in summer; (2) a disused mill dam, some 300 yds. from the first mill, draining the adjoining hill land, is allowed to fill during the day and night, and furnishes water from 6 to 8 a.m. and 4 to 5 p.m., producing about 13 kw. There is a fall of 140 ft. from this dam to the power-house. The third turbine referred to above is supplied from the River Ludd, which flows through the valley past power-house No. 1, a public path separating the river and building, consequently the third turbine could only be installed on the opposite bank, as will be seen in Fig. 2. A hundred yards up stream is the dam providing the necessary fall, and from this a goyt was built to power-house No. 2, a tail-race being sunk to about 50 yds. down stream. In building both goyt and tail-race, the hillside formed the back wall, and the stone taken out was used for the front wall and bottom of the goyt, the tail-race being sunk in solid rock. The turbine operates a vertical shaft, bevel geared into a horizontal shaft, crossing the river on 12 in. **H** girders, and terminating in a 60 in. pulley wheel inside power-house No. 1. The distance across the river between the buildings is 40 ft. The turbine runs at 108 r.p.m., the main shaft 170 r.p.m., and the dynamo to which it is belted 650 r.p.m. The two sources of water in No. 1 power-house are controlled by piping and valves, arranged to divert either supply to either turbine, or to run both turbines from one supply.

The above are the chief hydraulic features of the plant, the electrical arrangements calling for no special comment, except that automatic switches are used wherever possible. The generators are run up singly and switch themselves in on the line when up to voltage, and continue running without attention. The battery installed at the mill is under control of special switches, and when placed in circuit needs no other attention than regulating about

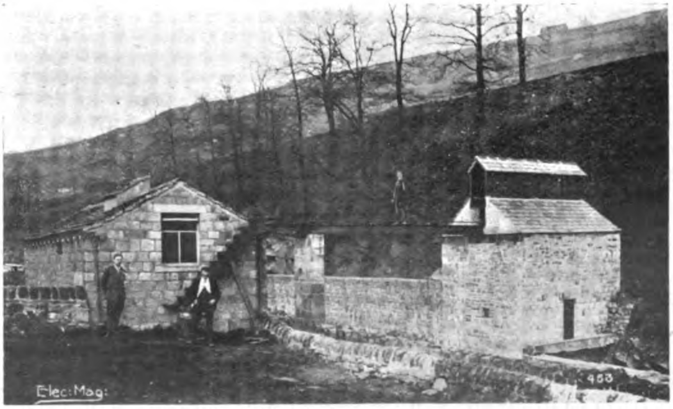


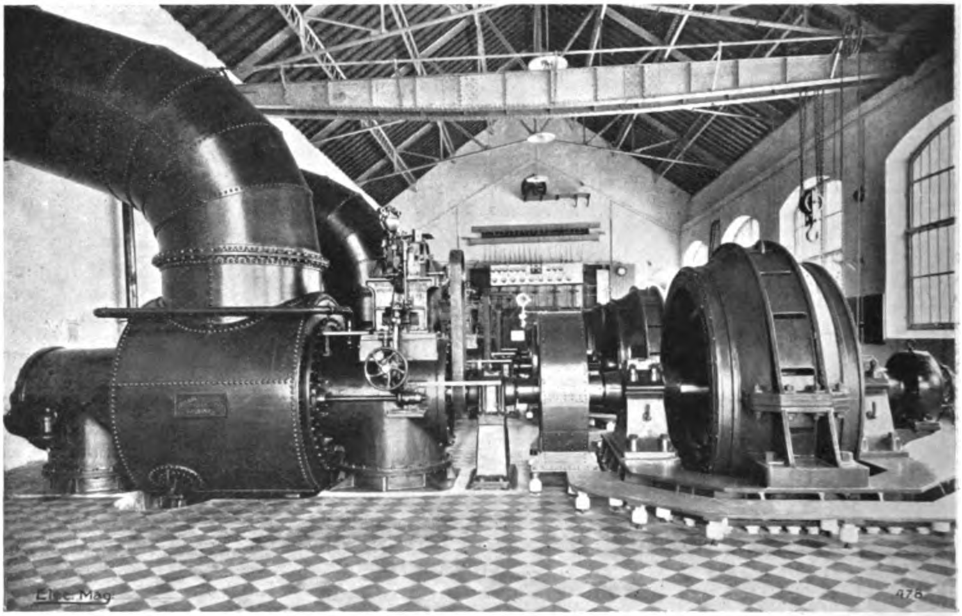
FIG. 2. EXTERIOR OF BOTH POWER HOUSES.

every half-hour. Three machines are run for the full load, but during the day one only is used for the battery charging. When so running, a Lyons liquid resistance is used to keep a bus bar pressure of 200 volts, all current passing through it. By adjustment the pressure can be maintained at 200 volts even though the battery runs up to 280 volts.

The combined plant has a capacity of 76 kw., and has been running almost three years with little or no attention. It furnishes current to about 1,300 lamps, which are now being extended to about 2,000, thus fitting up the mill complete. There is also a private house—the home of the owner of the mill—half a mile away, supplied from the above source with 120 lights and power for motor for dairy farm, etc. In another direction, and also half a mile away, the home of one of the owner's sons is in course of fitting. It is proposed to light the church of the district also. As a commercial investment, the plant shows 20% on the entire capital outlay. It has been designed by the author and is typical of what can be done, where falling water in any volume is available, in the way of generating hydro-electricity.

HYDRO ELECTRICITY FOR SMALL FRENCH FACTORIES.

On the river Ain, in the French Jura, near Lake Geneva, a hydro-electric plant has recently been completed for furnishing power to the numerous small workshops abounding in the department and carrying on watch-making, tobacco pipe manufacture, wood turning, diamond polishing, etc. From the river Ain and Lake de Chalain, 28 miles up stream, the necessary power is drawn to operate a large power house at St. Mortier, at which point some 2,500 h.p. is available. An underground tunnel connects the lake and the river, and the flow is regulated by sluices. The power house was erected with some difficulty owing to the restricted area available, and frequent flooding of the site. There are four Picard Pistet turbines, each of 700 hp., running at 250 r.p.m., connected by a Raffard flexible coupling to Oerlikon 3 phase generators of 500 kw., 7,500 volts, 50 periods. The generators are of the inductor type, the field coil being central between two armature sections, built up on a frame 10 ft. dia. At normal load and $\cos\phi = 0{\cdot}8$ the efficiency is 93·5 %, the loss being divided as follows: Frictional loss, 24,300 watts; heat loss—armature, 10,300 watts; heat loss—magnet wheel, 1,810 watts; total 36,410 watts. A glance at the composite page of photos opposite will give a good idea of the plant and its accessories.

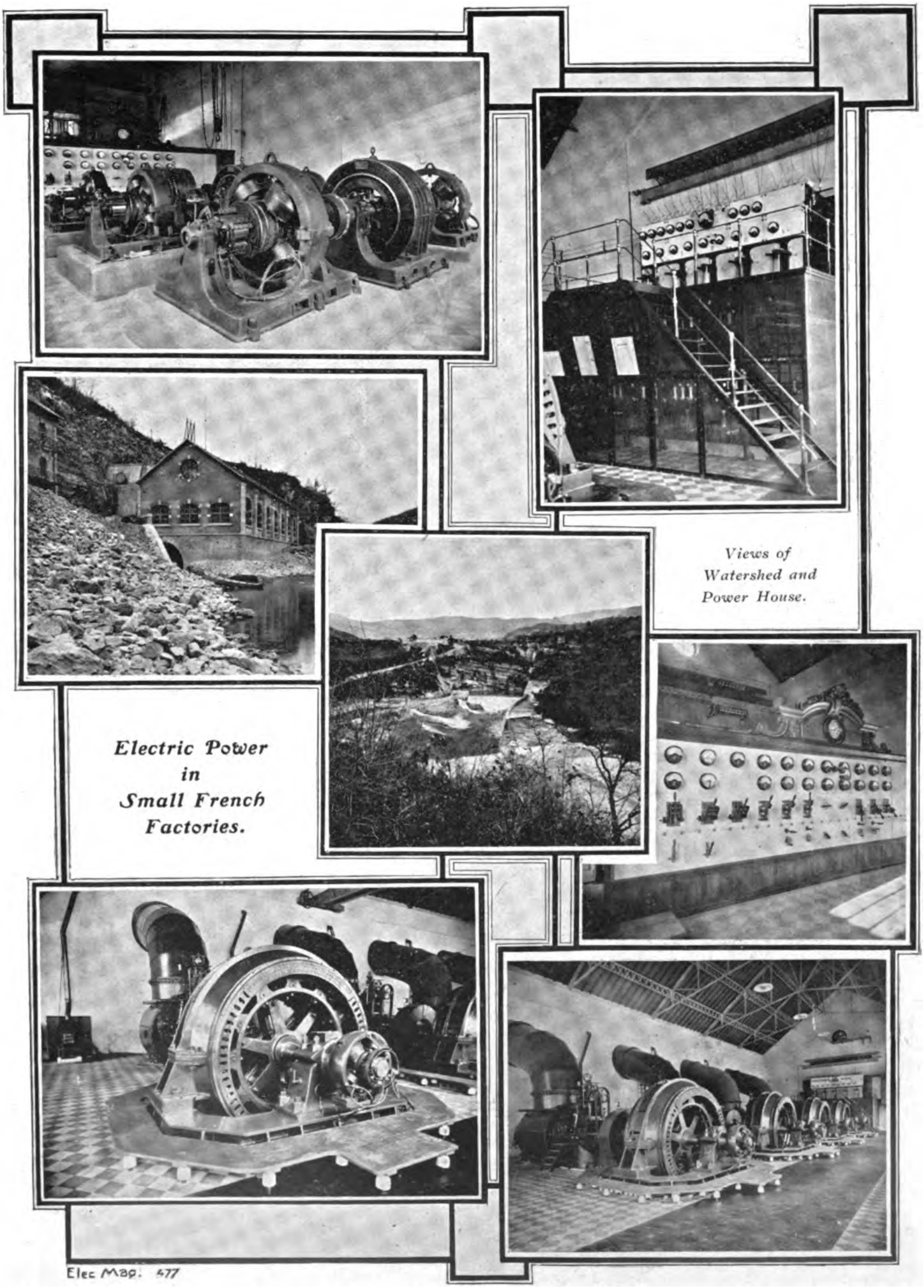


The Engine Room, St. Mortier.

Transmission is undertaken to four industrial centres:

St. Claude,	16·2 miles,	two circuits.
Mantua,	12 ,,	with small branches.
Armthed,	5 ,,	
Oernon,	5·12 ,,	with small branch.

The total length of lines is 65·4 miles, the wires being on 36 ft. poles, of which there are 3,940. There are 18 isolated transformer houses of brick, each containing a transformer; at St. Claude is a sub-station containing 3 motor generators, each comprising a 150 h.p. induction motor, coupled to



Electric Power in Small French Factories.

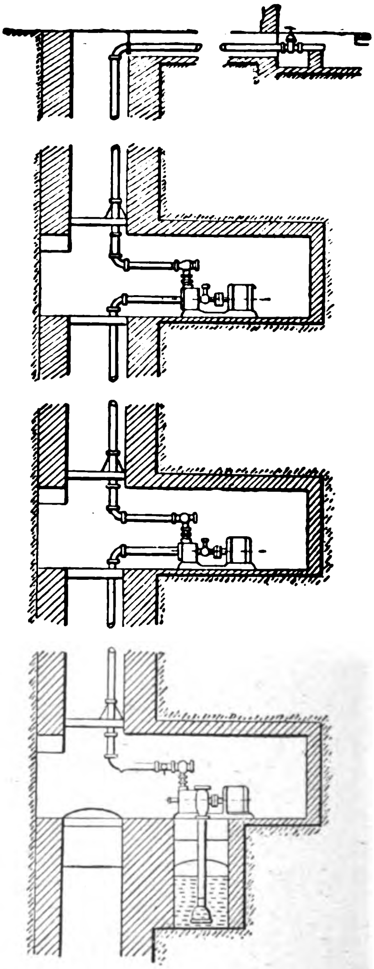
Views of Watershed and Power House.

Elec Mag. 477

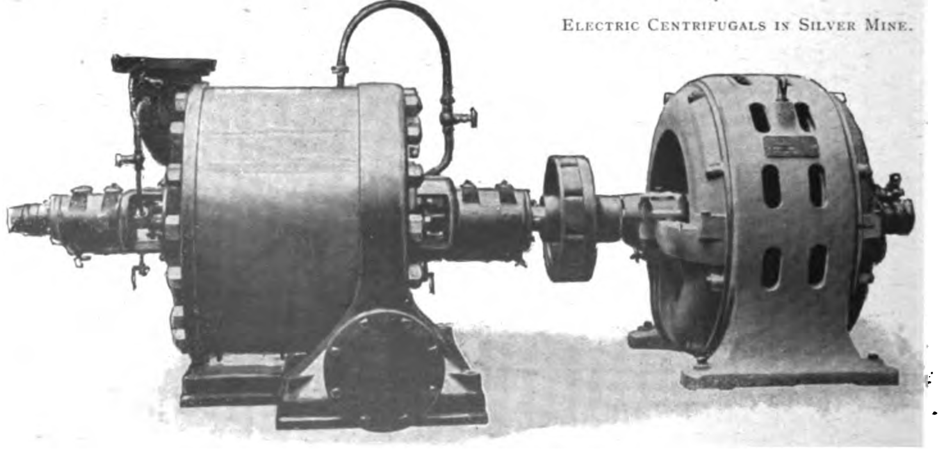
2-75 h.p. d.c. generators. The small factories are furnished with 110 volt 3 phase motors from ½ to 35 h.p., the a.c. service being at 120 volts and the d.c. service at 200 volts. Some 58 motors are connected with an aggregate capacity of 684 h.p., while in addition are 5,200 lamps equivalent to 58,000 c.p.; of these 2,000 are on three phase circuits, and 3,200 on d.c. circuits, at St. Claude alone. The installation is typical of what can be accomplished in supplying isolated factories—small consumers at that—on an economical basis with power and light. Our thanks are due to the Oerlikon Co. for their kindness in furnishing the photographs.

PUMPING WITH ELECTRIC TURBINE PUMPS.

THE value of the electro-motor for direct coupling to any device is no better exemplified than in operating centrifugal pumps. The development of high lift pumps for motor driving has been made the subject of much study, and as a result, such machines have been greatly perfected and put into practical daily use, often under severe conditions. No more strenuous work could be found than the draining of mines, and where plunger pumps have failed, and their prototypes "Express" pumps proved equally unsuitable, the turbine pump has given complete satisfaction. The diagram adjoining depicts an interesting installation of turbine pumps in a Spanish silver mine. In this case almost every type had been tried and discarded, until the employment of turbine pumps as depicted afforded a solution of the problem. In operating the pumps electrically, the old steam engines were used to drive dynamos by belt from the fly-wheel. Each pump can force 1,000 gallons of water per minute, against a head of 500 feet, and by the tier arrangement shown, each pump successively passes on the water to the surface. The water column is thus unbroken, and is constantly flowing steadily upward. The plant has been operating since 1898, and a saving of 15% in coal has been effected over former installations.



Electric Centrifugals in Silver Mine.



High Lift Turbine Pump.

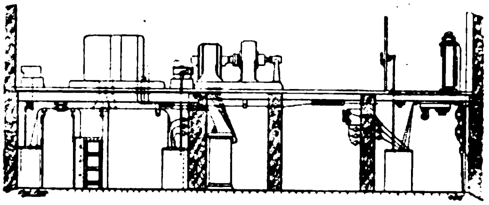
The photograph reproduced illustrates a modern high lift turbine pump, driven by a 160 h.p. induction motor, the pump having a lifting capacity of 1,000 gallons per minute against 320 feet head. Both motor and pump are the product of Mather & Platt, Ltd., who also installed the interesting plant referred to above.

* * *

WATER POWER FROM THE HUDSON RIVER.

Spiers Falls and Mechanicville, 40 and 15 miles respectively distant from Troy and Albany, N.Y., furnish power to both these places and districts, to the extent of 6,000 h.p. each. A recent issue of the *Electrical World and Engineer* gave some interesting details of the sub-stations supplied from these water power stations. Energy is delivered from Spiers Falls at 26,500 volts, and from Mechanicville at 10,800 volts, arrangement being made in sub-stations for transforming the former voltage to the latter, so that both plants can operate conjointly. At Waterville is a sub-station with nine 1,000 kw. transformers, which supply at the lower pressure a sub-station at Albany, where 300 kw. automatic regulators are used on the 10,800 volt circuit. At Trinity Place is a sub-station for the Albany Illuminating Co., originally run by steam plant, two phase and direct current. The old arc dynamos once driven by shafting were operated from synchronous motors driving the same shafting. The two phase distributors are connected to the three circuits through transformers coupled Scott fashion.

At Troy, energy is supplied to about 15,000 lamps, 763 arcs, and 125 kw. of motors. Steam was also used originally at this station, and the line shafting once steam driven is now operated by synchronous motors. The Union Traction Co., is in addition, furnished with power for its cars and railway in and between Albany and Troy, the transmission voltage, 10,800, being transformed to 375 for operating rotary converters. The change from steam to hydro-electric power from the Hudson, outlined above, represents an area of 675 sq. miles. The Dock St. sub-station, of which a plan and section are given herewith, supplies among other consumers the Schenectady Railway Co., which is also fed from two other stations carrying only railway loads. The switchboards are connected with the General Electric Co.'s plant, which can be drawn upon or be fed as required. The station is laid out on elaborate lines, and contains some fine examples of modern converting plant. Lighting and power switchgear are separately placed on each side of the station. The Schenectady service is metered throughout, there being 5,306 in use. Motors of a combined rating of 671 h.p. are coupled up, all being of the induction type. The railway company has secured a 20 years' contract for pumping the public water supply. Two pumps are driven by 800 h.p. motors, and deal with 12 million gallons daily. Other sub-stations are at Colone, Latham's Corner, and Ballston Spa.



End View of Sub-station. Hudson River Power.

* * *

GENERAL POWER NOTES.

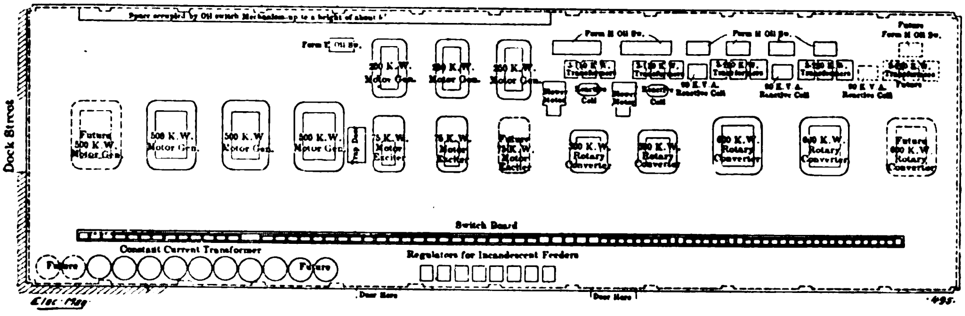
* * *

The Tyneside Electrical Pioneer.

The Newcastle-upon-Tyne Electric Supply Co., Ltd., has hit on a happy method of notifying monthly its customers, or rather its would-be customers, that it supplies electric power, and also what electric power can do. A neat and handy booklet with the above title contains useful (and humorous) particulars on electrical and other subjects, and it should tend to popularise the consumption of electrical energy on the Tyneside.

The Boston Edison Co.'s Plant.

The Edison Electric Illuminating Co., Boston, Mass., is now building a large new steam-turbo station of 60,000 kw. in twelve 5,000 kw. units. The old plant comprises six 1,500 kw. sets, driven by reciprocating vertical engines. The new station adjoins the old, and both are advantageously placed on the harbour side, where land is cheap, coal can be easily handled, and condenser difficulties are overcome. The plant is an extremely interesting one, and in our next or succeeding


Space occupied by Oil switch Mechanism up to a height of about 6'
Dock Street
Form K Oil Sw.
200 K.W. Motor Gen.
Future 500 K.W. Motor Gen.
500 K.W. Motor Gen.
75 K.W. Motor Exciter
Future 75 K.W. Motor Exciter
Form H Oil Sw.
Future Form H Oil Sw.
Transformers
Blower Motor
Reactive Coil
90 K.V.A. Reactive Coil
300 K.W. Rotary Converter
600 K.W. Rotary Converter
Future 600 K.W. Rotary Converter
Future
Switch Board
Constant Current Transformer
Regulators for Incandescent Feeders
Door Here
Elec. Mag.
495.

Plan of Dock Street Sub-station. Hudson River Power.

issues we shall hope to present our readers with an illustrated account. At present the company is supplying nearly 652,000 arcs and incandescents, and 23,890 h.p. in motors. *The Electrical Review* N.Y., 21/5/04, contained a full description of the station.

Cloth Cutting by Electricity.

A NOVEL application of electricity in the tailoring trade was described recently in *The Scientific American*. In giving some account of the immense establishment of A. B. Kirschbaum & Co., Philadelphia, reference was made to a neat electric cutter, used to cut through many thicknesses of cloth. A long table is laid out with several lengths of cloth superimposed, on the top layer of which the requisite patterns are marked to avoid waste. A cutter wheel, rotated at a high speed by a small motor, is then run over the markings and the cloth cut clean through. A small lamp is affixed, to afford light after dark.

Electricity in Japan.

THE electricity plant at Tokio bears comparison, it seems, with the largest and finest in Europe. Some 3,720 kws. are installed, which will soon be increased to 6,400. Subscribers are getting more and more numerous, the number of applications averaging about 1,500 monthly. When the new machines will have been put in, the power house will be enlarged and the total capacity increased to 10,000 h.p., which, though already a respectable figure, will still doubtless be insufficient if the municipality carries out its idea of laying down a line of urban and suburban trams. Amongst other signs of electrical progress in Japan, we may note that the Tamis will be utilised for lighting three adjacent towns, about 10,000 h.p. being necessary for this, and that the municipality of Osaka is considering the installation of a new tramway line. Also Shinavaga and Kanawaga will soon be connected by an electric line 32 km. long.

Power Plant at Bilbao.

A NEW and interesting installation for supplying light and power is in operation at Bilbao. The power house is near Quintana Martin Gallendez, 70 km. from the city, and is fed with water from the Rio Ebro by a mill race, 11 km. long and 10 m. in section, which runs direct from a barrage on the river, the head of water available being about 20 m. There are four generating sets of 1,000 h.p. each, the three phase alternators being connected to the turbines by elastic couplings. Four sets provide exciting current at 110 volts. The turbines are by Escher Wyss, Zurich, and are of the Francis type with moveable guide vanes operated by an arm attached to a piston enclosed in a cylinder, both ends of which may be put in communication with the oil pumps through valves actuated by the turbine governor. Oil cooled step-up transformers raise the pressure from 3,000 to 30,000 volts. All the switchboard fixtures can be handled in perfect security. The transmission line is taken to a sub-station at Bilbao, where the pressure is reduced to 3,000 volts. The distributing system is partly underground and partly overhead. Large motors are supplied direct with current at 3,000 volts, and lamps and small motors at 100 volts, through suitable transformers.

Power Schemes in New Zealand.

IT is very probable that considerable use will be made of water power, both in the North and South Islands of New Zealand. The Government have already commissioned experts to report upon the subject, and when the investigation has been completed, doubtless some important power schemes will be inaugurated. In the North Island some eighty likely streams and rivers have been suggested for the supply of water for power stations, and in the South Island about ninety rivers, streams, and lakes are looked upon as equally suitable spots. Marlborough, Nelson, and Westland are districts in which hydro-electric plants will arise with the demand for power, and Christchurch will probably be supplied from the Waimakariri and Rakaia rivers. Between Lakes Tekapo and Pukaki a fall of no less than 730 feet can be utilised, and proposals to connect other lakes with lower falls between are on foot. The most important power site is near Lake Hauroto, where the cutting of a tunnel would furnish a fall of 515 feet, and it is estimated about 150,000 h.p. daily. Excellent opportunities will be afforded here for the supply of power house plant, and our Antipodean friends will be expected to remember that British engineers can meet their requirements.

POWER NEWS IN BRIEF.

Electric Sterilising. We are informed that Nice will shortly be provided with an electric sterilising plant for its water supply. 24 million litres are to be treated daily, and it is hoped that the typhoid fever microbes will be completely destroyed by the electric process. Similar plants will, it appears, be put down in several towns along the Riviera.

Rhine Hydro-Electricity. So successful has been the Rheinfelden station, that the remaining two of the three falls available are shortly to be utilised. The original plant will continue to devote its 16,800 h p. to the manufacture of aluminium; but the new plants, to develop 30,000 h.p., will distribute energy throughout Basle and Rheinfelden respectively.

Switch Houses. Our contemporary, *The Electrical Review* (N.Y.), recently commented editorially on the term "switchboard," and remarked that the development of that section of the power house, necessitating as it does the erection of brick structures, compels the use of the expression "switchhouse" in referring to the controlling portion of the power plant The generating station, at first divided into the boiler and engine rooms, is now comprised of a third section, the switchhouse.

Water Power in Italy. The Italian Minister for Commerce and Agriculture has just published the 30th issue of the "Descriptive Memoirs on the Hydrographic Map of Italy," which contains reports on the condition of the Abruzzi and Marca drainage areas, giving at the same time the hydraulic energy available in these provinces. The Tevere provides for 500,000 h.p., of which 100,000 only are as yet utilised. The Garigliano, Volturno, Sarno, Tusliano, and Sele can together supply 180,000, 35,000 of which are in use The Marta, Fiora, Ombrone, Arno, and Serehio together develop 75,000 h p., of which 15,000 are in use Lastly, the Alterno, Pescara, Sangro, Salino, Vomiano, and a Tronto have a capacity of 212,000 h.p., of which 25,000 are employed. To sum up, 592,000 of the total 767,000 are still available.

The Electric Advance. *The New York Daily World* delights its readers with the following: "Like the Japanese in Manchuria, the electric motor is pushing ahead, flanking its adversaries and crowding them off the earth. It has forced most of the horses off the surface car lines of New York; it has shoved the locomotives off the elevated roads, and now it is about to take possession of the suburban railways. Before long we shall be riding to White Plains and Croton on electric trains connecting with the subways, the New Jersey commuters on the lines of the Pennsylvania, the Erie and the Lackawanna will come to town by electricity, and it will not be surprising to see the motor replace the engine along the whole length of Long Island."

TRACTION & Transport

The extraordinary and rapid developments in electric traction call for a special section entirely devoted to this work. The main systems in vogue or projected in every country will be specifically considered, and everything that appertains to the transport of humanity or materials will be scientifically and practically dealt with.

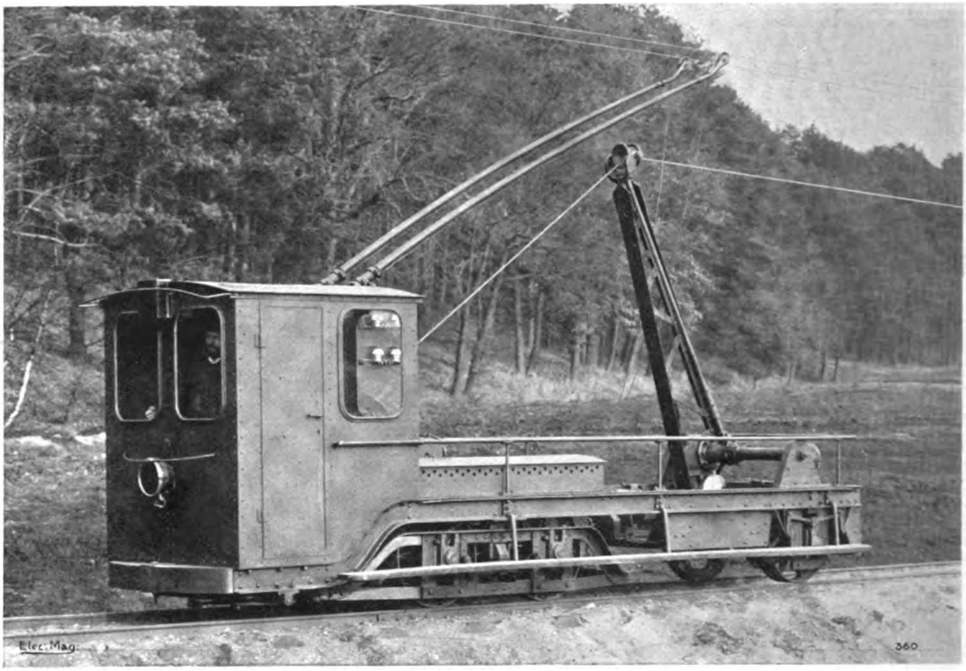
Electric Canal Haulage Devices.

By FRANK C. PERKINS.

THE question of hauling canal boats by electrically operated locomotive *tracteurs*, towing motors and boats has received a great deal of attention during the past decade in Europe, as well as in America, and with the enlarging of the canals on both continents there is every reason to believe that electric power will be utilised extensively within the next few years. It may be of interest to consider some of the details of construction of the haulage devices utilised on canals up to the present time employing electric power. At the Teltow Canal, in Germany, both electric tug boats and electric locomotives have been employed by the Siemens-Schuckert Werke and the Teltow Canal Building Management, and have proved very satisfactory, the efficiency of the boat, however, being considerably lower than that of the locomotive. The electric tug boat used on the Teltow Canal is provided with a trolley pole 40 ft. in length for conducting current from the trolley wires along the bank to the electric motors driving the boat propellers, a second overhead wire being used for the return current, while a storage battery of 330 cells is also provided for supplying current when contact is not made with the trolley wires.

This electric boat is 12·5 ft. wide and 60 ft. long, and is said to operate at 13·5 kilometres per hour with 45 kilowatts without load, and when hauling a load of 450 tons at a speed of 5 kilometres per hour the power utilised was 43 kilowatts. The electric motors are directly coupled to 3 propellers and operate at 600 revolutions per minute, the capacity of the motors being 20 h.p. each. The motors are operated at a pressure of from 400 to 600 volts, the lower pressures being utilised when the storage battery is placed in circuit, and the higher voltages when the overhead trolley lines are utilised. The electric locomotive employed on the Teltow Canal is provided with a rope drum, and an electric motor is utilised for winding up or unwinding the hauling rope. The hauling rope passes over a framed truss on the locomotive which is so arranged that it may be moved up and down in order that the rope may not interfere with other canal boats. A second electric motor is utilised for lowering and raising this truss, and a third motor is employed for operating the electric locomotive. This canal haulage device takes considerably less current than the electric tug boat doing the same work. A number of canal boats weighing 1,000 tons were hauled by the electric locomotive with a trifle over 19⅓ kilowatts, while on another trial with a load of 1,250 tons, but a little over 16 kilowatts was required, the speed being 4·3 kilometres per hour and the

ELECTRIC TUG ON TELTOW CANAL.



ELECTRIC TRACTOR ON TELTOW CANAL.

tractive force 900 kilograms. This electric locomotive when hauling 4 boats weighing 1,450 tons at a speed of 4·35 kilometres per hour required a trifle over 19 kilowatts, the tractive force being 2,000 kilograms at starting and 1,000 kilograms when the boats were under weigh.

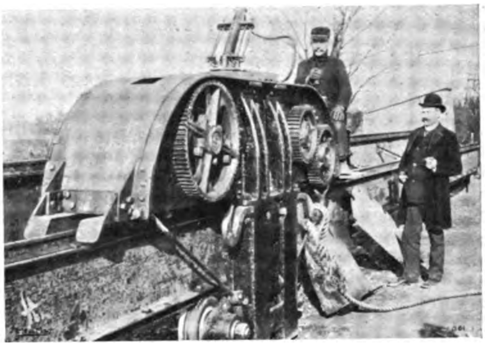
The accompanying illustrations show the electric canal haulage devices employed on the European as well as the American waterways during recent experiment. On the Finow Canal, the Köettgen electric canal haulage locomotives have been used, employing both single rail and double rail types. The locomotive employing the single rail has a pair of broad tyre wheels which travel along on the ground nearest the canal, the single rail with two small wheels which are grooved taking a large proportion of the power. The motor weighs about 2 tons, and has a capacity of about 15 h.p., giving a speed of about 4 miles per hour. The Köettgen two rail electric canal haulage locomotive on the Finow Canal is operated on an ordinary track placed on wooden ties and operates at a speed of about 3½ miles an hour with several loaded canal boats weighing over 300 tons.

Both electric tug boats and electric tractors have been employed on the Charleroi and Brussels Canal, in Belgium, the latter being operated on an ordinary tow path without a track of any kind, the co-efficient of traction being 4·5 kilograms per ton. It is stated by Mr. L. Gerard that the efficiency of the tractors after a year's service is about ·48, and when travelling at a speed of 4 kilometres per hour it takes 4·1 kilowatts without a load, and when hauling a barge of 140,000 lbs. at the same rate the power required is 4·85 kilowatts. This system is said to be impracticable on account of the excessive wear and tear of the wheels of the tractors and the excessive repairs required. Experiments made at Disquercq, on the Charleroi Canal, in Belgium, showed that full speed could be reached in about 45 seconds with a light tractor on rails, and the results of experiments made on other canals would indicate that a track of some sort is absolutely necessary in order to obtain commercial results with the electric canal haulage. On the above canal, experiments were made to find the pull at starting, and it was found that with a heavy tractor running on the tow path and a pull falling from 635 kilograms to 120 kilograms, a speed of 3·5 kilometres per hour is reached in 50 seconds with a barge of 70 tons. When utilising a tractor weighing 1,650 kilograms giving a steady pull of 264 kilograms, the above speed is reached in about ½ minute.

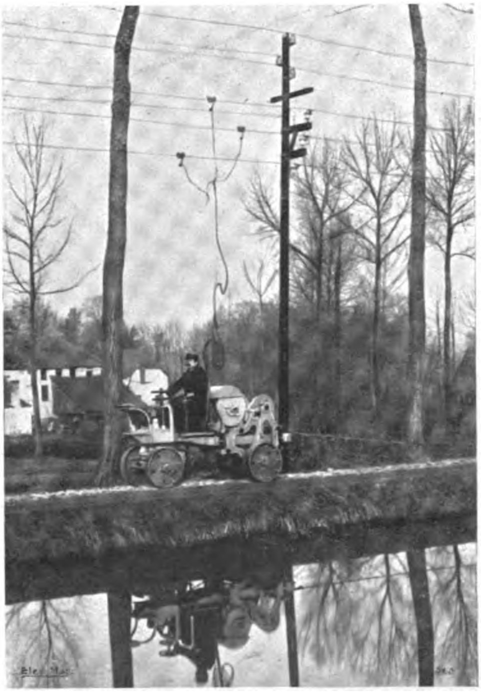
An electric tricycle type of haulage engine has been utilised on the Burgungy Canal, which also operates without the use of a track of any kind. This tricycle locomotive is operated along the tow path, receiving its current from overhead trolley wires, and operates at a speed of 1½ miles per hour, hauling several canal boats weighing several hundred tons each. This tricycle haulage engine weighs about 2 tons and is equipped with a motor of from 6 to 10 h.p. capacity.

The electric canal haulage system of Ganz & Co. utilises a single track and a monorail locomotive which has a separate wheel running along on the tow path, a large proportion of the weight of the engine resting on the rail. With this haulage device it is stated a most excellent working cost per ton has been obtained.

In America, the first tests of electric canal haulage were made on the Erie Canal about 10 years ago, 2 Westinghouse electric motors being utilised to drive propellers taking current from a trolley running along the bank. This test was made by Mr. F. W. Hawley, at Rochester, but while quite successful was opened to the objection that an excessive wash and suction was produced which was injurious to the bank in case a fair speed was employed. The Lamb system was tried on the Erie Canal, at Tonawanda, and also on the Raitan Canal, using a telpher electric motor travelling along two cables located one over the other, the lower one for traction and the upper one for bearing.



Electric Tractor on Erie Canal.



Tractor on Charleroi Canal, Belgium.

On account of the heavy construction required for the overhead Telpher system, it has not been placed in operation, but another system is now in operation in America on the Miami Canal, using a polyphase alternating current for transmission and an overhead trolley line with a electric hauling locomotive on an ordinary double track. The latest American system for electric canal haulage was devised by Stephen W. Wood, and was placed in operation on the Erie Canal at Schenectady, near the General Electric Works, by the International Towing & Power Co. This is a monorail system, similar to that advocated by Thwaite, in England. The electric towing motors are similar to a Hogback Mine locomotive, and measure 2½ ft. high from the rail, 2 ft. wide, and about 10 ft. in length, two narrow gauge type of 40 h.p. electric street railway motors are employed, one at each end of the machine, the controller and seat for the driver being located at the rear. The motors are geared down by double reduction to about 40 to 1 on account of the low speed required for canal hauling. Each of these electric motors is utilised for driving a grooved wheel somewhat less than 2 ft. in diameter, travelling along the upper rail. Two large hucks are provided for the tow ropes, and the motors may be operated forward or backward by properly turning the controlling switch. The track along the canal used for this experimental work is about half a mile in length, short posts being erected every 25 ft. supporting a plate girder of 18 inches, a second being employed about 3 ft. distant, the girder on the side away from the canal being raised above the inner one so as to allow the towing motors to pass each other. It is estimated that with this electric haulage device from 3 to 6 boats can be hauled at a speed of from 4 to 6 miles per hour at a very low cost per ton per mile, while the present cost with mules is said to be very much greater with a speed of only 1½ miles per hour and a smaller load. There is every reason to believe that in the near future electric canal haulage devices will be utilised extensively in America as well as in Europe, this system being as well adapted for barges of 1,000 tons, as for canal boats of 250 tons each.

Regenerative Control of Electric Cars.

By G. W. de TUNZELMANN, B.Sc., M.I.E.E.

One of the strongest arguments of the advocates of the induction motor for the propulsion of cars on mountain railways and tramways with steep inclines has always been found in its inherent property of running at a nearly constant speed with very wide variations of load, taking more or less power as may be required, so long as the load remains positive, and being transformed into a braking generator when the load becomes a negative one. C. P. Steinmetz has recently patented an interesting method of obtaining a similar braking action from a repulsion motor, by temporarily converting it into an induction motor when operating at a speed above synchronism. The practical feasibility of this system is due to the fact that the maximum efficiency is obtained from a repulsion motor at a speed which is considerably above that of synchronism, and such a motor may therefore be converted into a braking generator by locally short-circuiting sections of the secondary winding, the primary remaining in circuit with the source of supply. This might be effected by connecting the commutator segments, but to do this with a controller as far away from the motor as is necessary for railway or tramway work would involve very considerable complication.

It is therefore found preferable to close the secondary circuits by means of taps, taken from the winding in the manner employed in the case of rotary converters, and then connecting these taps together. The arrangement employed is shown diagrammatically in Fig. 1.

A is a source of alternate current supply, M the motor, with a primary P and secondary S; connected to the secondary is a commutator E. Collector rings c, d, e, are connected to taps from the secondary, while taps f to p inclusive, are taken from the primary at points suitable for control, when the motor is operating as a repulsion motor.

The controllers C and B are shown with the contacts developed into a plane, the stationary contacts being indicated, as usual, by circles, and the moveable ones by rectangles. The controller C is employed to operate the motor in the ordinary manner as a repulsion motor. By means of the controller B, short-circuiting is effected through the various resistances R , R^2, R^3, or with all these cut out, according to the braking effect required.

With the shunt-wound continuous current motor, the regenerative braking action comes into play automatically, just as in the case of the induction motor, whenever the normal speed is exceeded.

This property, together with that of automatic speed regulation, which would enable a car to maintain a fairly constant speed over varying grades, without aid from the controller, and even under considerable variations of pressure, would seem to point to the shunt motor, as the ideal continuous current motor for traction purposes.

With the series motor, the maintenance of a constant speed over varying grades can only be attained by the aid of the controller, at the expense of a certain waste of energy, or by working with a very highly saturated field, which is even more wasteful. In order to obtain an electrical braking effect with this class of motor, it is necessary to cut off the motor from the line, and short-circuit it through resistances.

How is it then, that the use of series motors for railway and tramway work has become so practically universal, that a proposal to employ shunt motors, except in the case where the power is derived from accumulators, should be regarded as almost heretical?

The most serious objection to the use of shunt motors for traction is to be found in the difficulty of insulating the field coils, and in the greater bulk and the fragility of the fine wire of which they are composed. Both of these difficulties may be obviated by replacing the shunt excitation by separate excitation by means of a low voltage battery of accumulators, the separately excited motor having the same properties as the shunt motor. This method has been adopted by Siemens and Halske on the Barmen rack railway.

Other objections are:—(1) Owing to the field excitation being maintained constant, a momentary sudden rise of pressure may occur

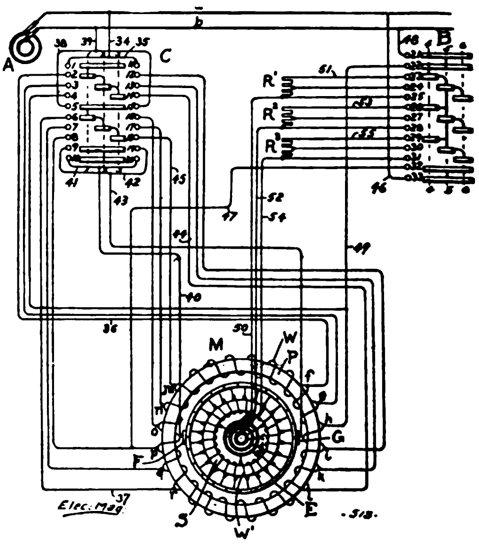


Fig. 1.

by the removal of the load at the beginning of a heavy down grade, when running at full speed. This may be sufficient to burn out the lamps on the car. A similar result might occur from the use of a series-parallel controller with shunt motors. (2) Owing to the low inductance of the armature, any irregularity in the brush pressure may give rise to electrical oscillations in the line, which may affect neighbouring telephone wires. This can be reduced to a negligible amount by means of inductance coils, but at the expense of some waste of energy. (3) There is more liability to sparking than with the series motor, especially in the case of too rapid supply of current. (4) Owing to the high inductance of the field coils, the field circuit must be gradually broken through resistance, or short-circuited at the moment of breaking.

In the course of last year, Mr. J. S. Raworth succeeded, after many previous failures, in adapting shunt and compound-wound motors to traction purposes. They were first introduced on the Devonport and District Tramways (on which many of the gradients are very severe), and with such satisfactory results that they have been, or are being, introduced on numerous tramway systems with heavy gradients.

A severe practical test of the efficiency of the system in securing safety on heavy gradients was made by removing the trolley from the line during a steep ascent. No brake being applied, the car, of course, began to run backwards, but the pressure of the driver's finger on a lever, thereby switching in a high resistance series coil and short-circuiting the motor, was sufficient to prevent the speed from exceeding three-quarters of a mile an hour.

In addition to the safety obtained in this manner, it was found, in a large number of trial runs, that an average saving of 30 per cent. was effected in the power consumption.

Mr. Raworth's specifications have now been published, and the claims were reproduced in our April issue. The improvements are, however, of sufficient interest and importance to call for more detailed notice.

Referring to Figs. 2 and 3, a regulating lever, *d*, carrying a pin, *q* (Figs. 7 and 8), is pivoted at *e* in the controller casing *f*, and is arranged to have a fore and aft movement after the manner of the reversing lever of a locomotive, and to carry contact pieces which slide over contact blocks, *gh*. These are so connected up as to modify the strength of the shunt-motor fields *b*, *b*, either by varying the resistance in circuit therewith, or by altering the number of sections of the field windings, the arrangement being such that a forward movement of the regulating lever will reduce the strength of the field and increase the speed, while a backward movement will increase the field strength and reduce the speed. When the regulating lever reaches the blocks g^1, h^1, which are dead, the field circuit is broken entirely.

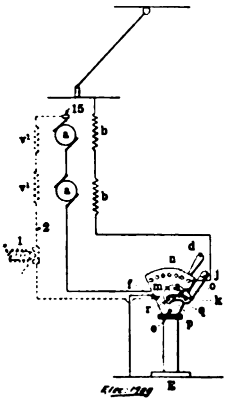


FIG. 2.

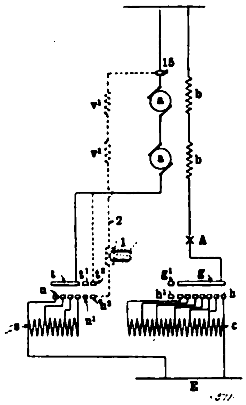


FIG. 3

The armature circuit is controlled by the bell-crank lever *j*, pivoted at *k* and carrying contact-pieces which move over the contact blocks, *t*, *u*. When the lever *d* is in its most forward position—that is, when the field circuit is broken—*j* can be moved just sufficiently to allow the pin *q* to leave the notch *r* and come into line with the slot *p* (Fig. 4). By moving *d* backward the field circuit is closed, and the resistance *c* gradually removed. On reaching the most backward position, the pin *q* comes into line with the slot *o*, and the lever *j* is left free to turn about the pivot *k*. It is then possible to close the armature circuit by a movement of *j*, and the car moves slowly forward. Until the pin *q* comes into line with the slot *n*, however, it is impossible to move *d*, and thus all resistance must be cut out of the armature circuit before the car can be accelerated by pushing forward *d*. The regulating or speed lever *d* is prevented by the length of the slot *n* from being pushed so far forward as to reach the contact blocks g^1, h^1, and thus break the field circuit while the armature circuit is still closed. To stop the car, the speed lever is drawn backward, thus strengthening the field, until the speed of the car becomes very low, whereupon the starting lever *j*, being thereby unlocked, opens the armature circuit automatically by the released energy of a weight or spring.

The switch governed by the power lever *j* can be so arranged that after breaking both positive and negative connections, *i.e.*, when its contacts are on the contact blocks t^1, u^1, it will short-circuit the armatures through a special series winding of fewer turns than is the case with ordinary series motors. For this purpose, as is shown in Figs. 2 and 3 in dotted lines, an additional pair of contacts, t^2, u^2, are provided in the power part of the controller. The power lever switch contacts move on to these whenever the power circuit is broken. To prevent the possibility of the armatures being short-circuited through the series-winding whilst the field is excited by the shunt winding, the controller is provided with an electro-magnetically operated switch 1 in the short circuit. This switch is magnetised and held open by the shunt field current, the windings of the switch being connected in series with this circuit at A. An automatic switch, 15, disconnects the armatures from line or battery when they are short-circuited. The motors, when thus short-circuited, act as an emergency braking arrangement. In some cases, however, the special series winding may be replaced by a resistance, in which case the electro-magnetic switch 1 is dispensed with. In descending hills, and when stopping the vehicle, the motors act as generators, and return current to line or to battery, and thus act as a brake. The braking action is also in operation when the motors are short-circuited through the resistance, and when short-circuited through the special series windings *v*'. The field-regulating contact blocks and those regulating the armatures are arranged in different zones for the better isolation of the one from the other, and the contact blocks for effecting the change from series to parallel may be swept by contacts carried by the power lever, but it is preferable to put them on a separate lever carrying a hollow cam, with which a pin on the power lever engages.

If it be desired to apply this regulating device to compound-wound motors, then the controller or regulator is arranged with two handles or levers partially connected together, with a spring or its equivalent between them so arranged that when the handles are untouched the spring will force them into a position whereby a switch short-circuits the series coils, and the upper surface of the guide traversed by the handles is cam-shaped, so that the short-circuit switch cannot be opened except when the shunt field is very strong. Figs. 5 and 6 illustrate diagrammatically an arrangement for the purpose, and Figs. 7 and 8 are detail views of the speed lever. The lever *w* is normally maintained in a position remote from the speed lever *d*. This may conveniently be done by a spring, *x*. The second lever *w* controls, through a connector, *z*, a switch, *y*, caused to normally short-circuit the series coils *v*, so wound as to augment the fields when the motors are acting as generators. The upper surface of the controller casing *f* is so formed for a portion of its length, 5, that a pin, 6, on the second lever is in contact therewith, to prevent the lever *w* being moved to remove the short-circuit on the series coils *v*. Such movement is, however, permitted to take place when the pin 6 is opposite a recessed part, 7, of the controller casing. This recessed part 7 is so situated that the removal of the short-circuit on the series winding can take place only when the fields are near their maximum excitation by the shunt windings. In arranging the controller in a fore and aft position it is desirable that it should be placed parallel with the centre line of the car, but where this cannot conveniently be done, it suffices to place it in such a position with regard to the driver, that for him to push produces acceleration, and to pull produces retardation.

The second patent refers entirely to compound-wound motors, the series winding being arranged to strengthen the field when the armatures are returning energy to the line, and, therefore, to weaken the field when the motors are receiving energy from the line. Referring to Figs. 5 and 6 it will be seen that in starting the car the series field winding is short-circuited and has no effect on the field. To increase speed, the driver pushes the speed lever, and the braking handle moves with it,

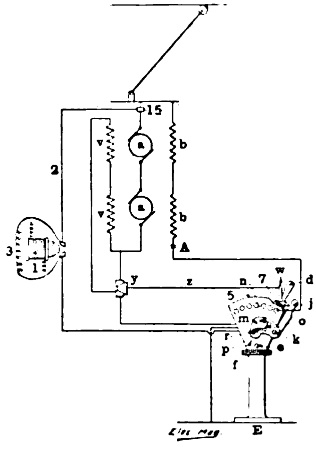


FIG. 5.

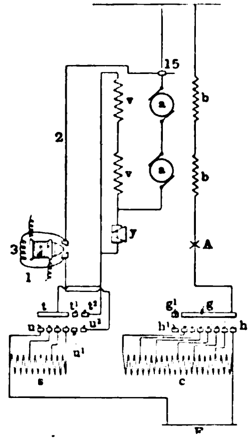
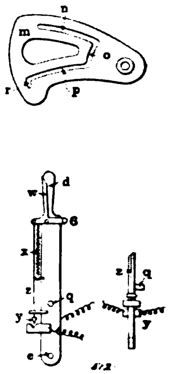


FIG. 6.



FIGS. 4, 7, 8.

the shunt field being reduced by the insertion of resistance. If the speed increases too much, he draws back the speed lever, removing resistance and strengthening the field. In descending steep hills the driver first draws back the speed lever until the increased strength of the field returns a strong current to the line, and then, if more retarding effort is required, he pulls back the braking lever, the effect of which is to remove the short-circuit of the series winding and to still further strengthen the field. The controller may be so arranged that in case of emergency—for instance, the trolley leaving the line—further motion of the lever and handle will short-circuit the armature through the series winding, thus bringing the car to a stop, or nearly so, without any connection with the source of supply.

With such a system of control there is no necessity to provide the vehicles with brakes, other than a hand-brake to hold the vehicle when stopped; but should the trolley leave the trolley wire, then, unless additional braking means are provided, there is great liability of a serious accident taking place. To avoid such an untoward occurrence by reason of the failure of the supply of energy, the power lever *j* is so arranged that, when released by the speed lever, it is moved on to contacts t^2, u^2, by which the armatures *a* are short-circuited on themselves. The driver, when he finds that the supply of energy has failed, also draws back the braking handle *w* to remove the short-circuit on the series fields. The motors then act as generators, and also as a very powerful brake. It will be seen that with this arrangement the armatures can be short-circuited on themselves when the fields are excited to a maximum by the shunt windings *b*. This, of course, would be harmful. To overcome this defect, the short-circuit 2 is provided with an electro-magnetic switch 1, the windings of which are in series with the shunt windings at A. The switch is thus magnetised and held open so long as current flows through the shunt windings. However, in some cases, when it is desired that the motors shall form a brake that shall come into operation immediately the power circuit is opened, the contacts of the switch 1 are spanned by a resistance, 3, such resistance being cut out of circuit by the closing of the switch whenever the current through the shunt windings *b* is interrupted. The switch 1 may, if desired, be so constructed as to perform all the operations necessary for short-circuiting the armatures through the series windings in the event of a failure of supply. Further, where there are two motors or more than one field coil in one motor, the two-motor coil, or two or more coils of one motor, may be ordinarily in series, but when great retarding effort is required, the two coils or sets of coils may be placed in parallel, thereby doubling the ampère-turns in the field or fields. Or the shunt windings may be in sections and so arranged that one or more or all of the sections may be brought into use as required, but so that on journeys where the car runs forwards and backwards the controllers shall be arranged

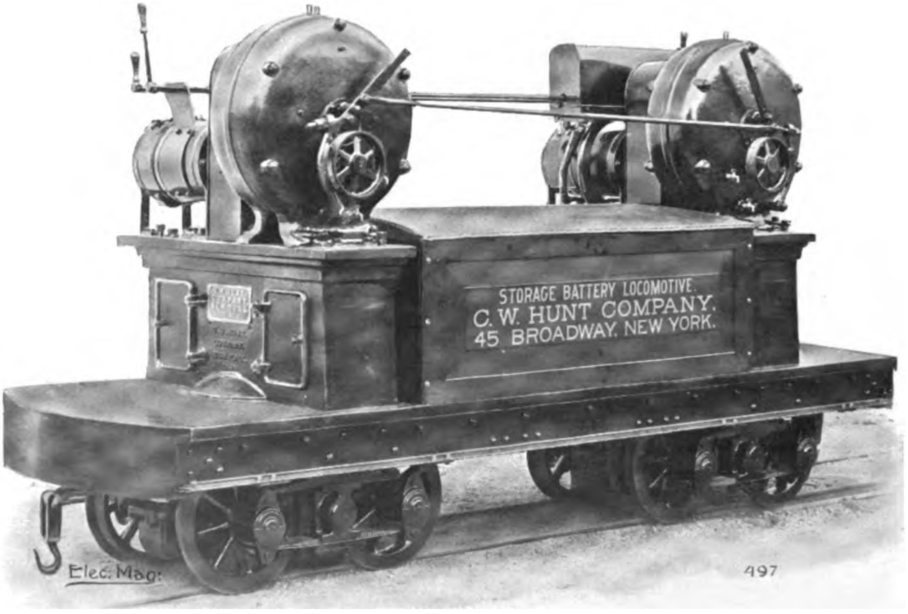


FIG. 2. STORAGE BATTERY LOCOMOTIVE.

so that the sections principally used on the outward journey shall be the least used on the homeward journey, to equalise the heating effect.

Storage Battery Locomotives.

It is only on rare occasions that the secondary battery figures in traction work, that is, for work of a heavy nature. Some tramways, or æsthetical reasons, have been equipped with battery cars, but capital cost and maintenance have militated against their wider employment. Probably there are few, if any, battery locomotives in use in this country, but in America, where enterprise is not lacking in the development of electrical apparatus, there are many such vehicles employed. In certain cases, the battery locomotive has been absolutely necessary as affording the only safe method of handling inflammable and explosive materials. C. W. Hunt & Co., New York, of telepherage fame, have done some excellent work in this direction, and supplied such locomotives for exceptionally heavy work. The Massachusetts Cotton Mills have a loco. hauling carloads of baled cotton about their yards (Fig. 1). A steam or a trolley electric loco. was out of the question on account of fire risk. Before the adoption of the storage battery locomotive, the cars were moved, one at a time, by three horses harnessed up tandem. The storerooms are so constructed that the horses would have no means of exit if driven in ahead of the car, so it had to be sent in "on the fly." Starting some distance back, speed was got up, and at the psychological moment the "tagholder" unhooked the "tag" fastened to the traces in front of the car. The danger of this method is obvious. Sometimes with a heavily loaded car the horses were unable to give it the necessary momentum, and the services of a loading gang had to be requisitioned. With the loco. this is all done away with now, and one man only is needed to operate it. In light switching service the batteries can be recharged at various times during the day, while the loco. is waiting between hauls. For heavier service it can be charged during the dinner hour, or after working hours in the evening. There is a separate gear case for each motor, so that, in an emergency, through accident, etc., the locomotive can be operated with one motor, which, while it would mean a corresponding reduction in the hauling capacity, would enable the continued use of the locomotive.

Fig. 2 (p. 603) illustrates an electric loco. in use at the works of the Buffalo Bolt Company. The cars hauled are of unique design, and were specially designed for the work to be done. The bolts and nuts are loaded into baskets containing about 250 lbs. each, and each car carries 20 baskets, *i.e.*, 12 in the sunk

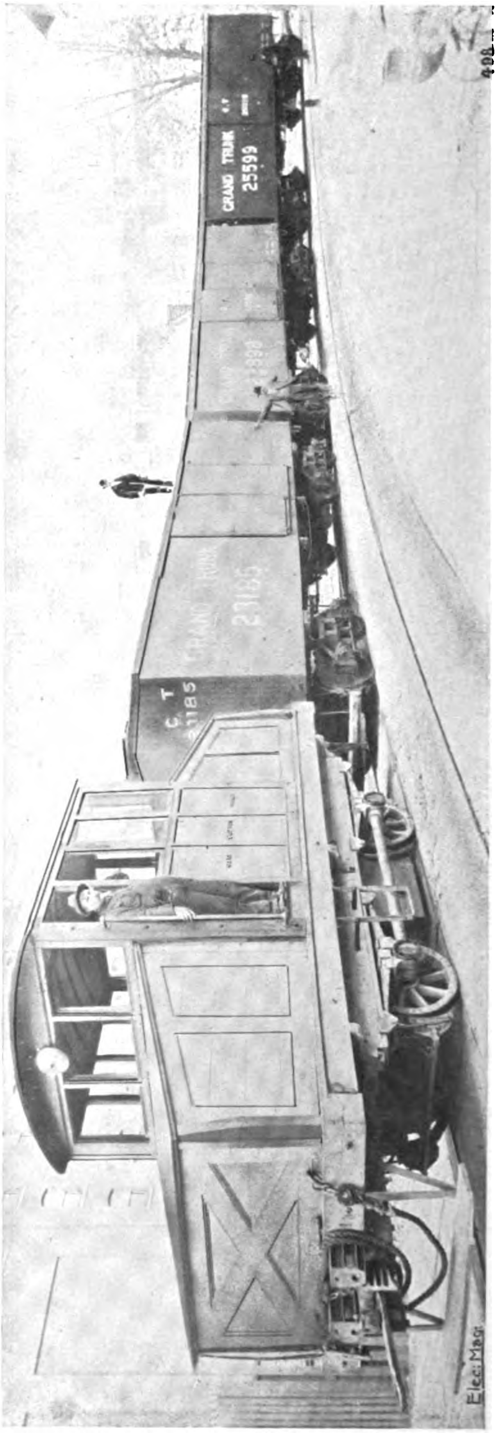
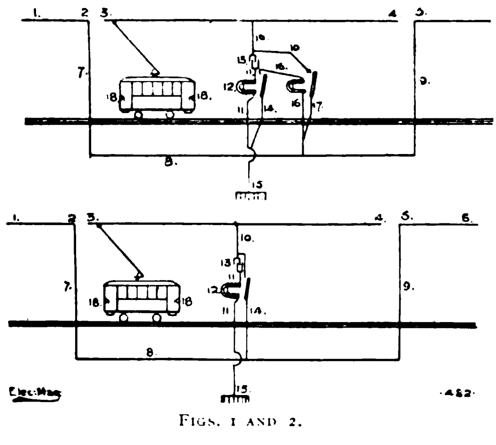


Fig. 1. Battery Locomotive Hauling Cars.

portion and four on each of the upper ends. The machines manufacturing the nuts and bolts deliver their products just a short distance above the floor level, and on this account the car is built low, so that the baskets can be drawn direct from their support on to the car without lifting. The Federal Lead Co., of Federal, Ill., have been using an electric locomotive in their foundry for several years, for handling slag cars and also for moving the ladle car, which distributes the molten metal in various parts of the foundry. This is much safer than overhead cranes or trolleys, as the flexibility of the system makes the slopping of the metal almost an impossibility.

LEVEL CROSSINGS ON TRAMWAY LINES.

M. CARBONNEL, of Uccle (Belgium), is the inventor of a system by which electric tramcars may continue to receive current while travelling on sections of the line where the use of heavily charged overhead conductors would be dangerous or inadvisable for reasons of traffic or security. As railway companies are well aware, serious accidents or, at any rate, very considerable damage may result from the breaking of a trolley wire just above a crossing, a point where usually it is impossible to apply the conduit system. In M. Carbonnel's system, the line is sectioned at the dangerous spot, and the conductors above that point are kept statically charged for only just so long as the vehicle remains underneath them. Further, the breaking of the trolley wire would immediately cut off the current automatically. As shown in Fig. 1, the line conductor 12,795 is taken underground across the dangerous section, and conductor 34 is in its normal condition, electrically isolated. As soon as the trolley comes in contact with 34, current produced by an independent generator 18 in the car passes into a circuit earthed at 15 and containing a condenser 13 and a relay 12, whose armature, when attracted, connects the line conductor 8 to earth through a second relay 16. The second armature 17 is then attracted and connects 34 with the line conductor, enabling the car to collect current just as if 34 formed part of the trolley line. Condenser 13 might be replaced by a transformer or a rheostat. In some cases it will be found advisable to insert a second condenser close to the generator terminal, so as to prevent the line current being shunted through the generator circuit. Relays 12 and 16 are both simple, easily adjusted and can be made in every way similar to those employed in telegraphy or telephony. They can be designed so as to be actuated only by a certain kind of current, a precaution which will be found useful, when for instance, alternate current is used on the line. Fig. 2 shows how by a very simple modification of Fig. 1 the second relay (16, 17) may be dispensed with.



FIGS. 1 AND 2.

Braking by Electricity on Tram and Railway Lines.

THE usual and well-known method for braking by electricity is to disconnect the motors from the line and work them as generators in a circuit of suitable resistance. M. Béthenod in *La Houille Blanche*, works out a mathematical expression for the space travelled by a vehicle before it is brought to rest by a brake of this kind. If the flux remains constant in a motor while it is acting as a brake, a permissible hypothesis on account of the saturation of the magnetic circuit, then the current and resisting torque are simply proportional to the speed, with a given resistance. The corresponding effort at the wheel rim can therefore be represented by an expression of the form *av*, *a* being a constant, and *v* the velocity of the car. The effort ϕ due to friction, gearing and hysteresis may be also considered as constant. Let P be the weight of the train, M its mass, μ the fictitious mass representing the effect of the rotation of the wheels and armature, f the traction co-efficient, i the slope of the line, F the effort at the wheel rim ; neglecting resistance of air, we get the following system of equations :

$$\mu \frac{di}{dt} - F - av - \phi - f P \quad - - - - - - - - - \quad (1)$$

$$m \frac{di}{dt} - i P - F \quad - - - - - - - - - - - - - \quad (2)$$

Eliminating F and putting M for m + μ

$$(m + \mu) \frac{di}{dt} = (i - f) P \quad av - \phi$$

$$M \frac{di}{dt} = (i - f) P - av - \phi$$

$$t -$$

$$\int_{v_o}^{v} \frac{M\, dv}{(i - f) P - \phi - av} = - \frac{M}{a} \log_e \frac{(i - f) P - \phi - av}{(i - f) P - \phi \quad av_o}$$

v^o being the value of v for $t - o$, or at the origin of time. Thus :

$$\frac{(i - f) P - \phi - av}{(i - f) P - \phi \quad av_o} = e^{-\frac{a}{M}t} \quad \text{whence}$$

$$v = \frac{(i - f) P - \phi}{a} + \frac{e^{-\frac{a}{m}t}}{a} [av_o + \phi - (i - f) P] \quad - - \quad (3)$$

In order that the car may come to rest, v must vanish for a finite value of t, then :

$$O=(i-f)\,P--\phi+e^{\frac{-a}{M}t}\,[av_o+\phi-(i-f)\,P]$$

or

$$t=-\frac{M}{a}\log_e\frac{(f-i)\,P+\phi}{(f-i)\,P+\phi+av_o}\quad - - - - - -\quad (4)$$

Now, if e be the space gone through at any time, then $v=\frac{de}{dt}$; putting this value of v into (3)

$$e=\int_0^t\frac{(i-f)P-\phi}{a}dt+\frac{av_o+\phi-(i-f)\,P}{a}\int_0^t e^{\frac{-a}{M}t}dt$$

$$e=$$

$$\frac{(i-f)\,P-\phi}{a}\times t+\frac{av_o+\phi-(i-f)\,P}{a}\left[\frac{M}{a}\left(t-e^{\frac{-a}{M}t}\right)\right]$$

in which expression t must have the value corresponding to $v=o$ and given by (4). Substituting :(5)

$$c=\frac{v_oM}{a}+\frac{(i-f)P-\phi}{a_2}\times M\times\log\left[\frac{(f-i)\,P+\phi+av_o}{(f-i)\,P+\phi}\right]$$

a being very nearly inversely proportional to v_o for a given initial effort t_o e varies as the square of the velocity, just as in the case of an ordinary brake.

TRACTION NOTES.

Paris-Orleans Electric Railway.

THE Liverpool and Southport electrification has its counterpart in the Paris-Orleans Railway. When making a new and more central terminus for their main and local traffic in 1900, this company laid out the entire plan on electric lines and built power and sub-stations and several electric locomotives. This installation has now been enlarged and the local service of the company as far as Juvisy, a distance of 12 miles S.E. of Paris, will be handled electrically by means of the multiple unit control system. The present electric locomotives will be modified for higher speeds and re-inforced by an additional three, which will be used to haul main line trains. The system presents many novel features, and the installation will be complete in July next.

Paris Tramways.

THE multiplication of traction systems in Paris is proverbial. Owing to the consistent opposition from æsthetic reasons by the municipality to all introductions of the trolley within its streets, promoters have made strenuous efforts to find systems combining the cheapness of the trolley with the neat appearance of the underground conduit, of which latter there are several miles in successful operation. The Cie des Tramways Est Parisien was formed to exploit a long mileage on the Diatto system of traction, and the experiment has resulted in a deplorable state of affairs for the shareholders. Every year the gravity of the company's affairs has become more serious. In 1903, the receipts for the system amounted to 5,072,785 frs., as against 4,377,444 frs. in 1902. Owing to the exaggerated expenses of working, strikes and other unforeseen expenses, the profit realised was only 412,799 frs. Liabilities from previous years, and payments for running powers, etc., reduce this sum to 237,623 frs. The company runs trams over some 50 km. on the East of Paris. During the first 18 weeks of the present year the receipts, compared with the same period of 1903, have diminished by 100,000 frs.

Resistance of Alternating Current in Railway Rails.

MR. A. Enström, in *Teknisk-Tidskrift*, April 9th, describes experiments, on the so-called "own impedance" in railway rails of the largest type usual on Swedish state railways (weight 40·5 km. per m), which have been carried out at the suggestion of R. Dalander. The "own impedance" of a conductor is the total apparent resistance against alternating current. This effect may be calculated theoretically for thin cylindrical wires, but experiment must be exclusively resorted to with conductors of irregular cross sections consisting of magnetic material. The resistance is measured by comparing it with a standard resistance free from induction. The number of periods with the alternating current used varies between 20 and 50 per second, while the current intensity could be altered up to about 300 amps; the tension curve of the alternating current machine was practically a sinoidal line. To separate the effective resistance from the inductive resistance, the phase lag between current and tension was determined by means of a Joubert contact disc. As may be inferred from the results, for a given number of periods the effective resistance will become dependent on the permeability of the conductor. For variable numbers of periods, the effective resistance in a round thread will increase as the square of the number of periods. The same resistance in rails, as shown by the author's figures, will show an increase proportional to the number of periods. This is accounted for on the increase of the density of the flux at the surface, occurring for increasing numbers of periods, while towards the centre there is a diminution; the permeability will at the same time show increase for low saturations.

Electric Tramways in Germany.

THE construction of electric tramways in Germany, as pointed out in a recent report by the Berlin Chamber of Commerce, has decreased during 1903, all the large towns having now adopted electric operation, while the present economical situation is not in favour of any further extensions of the existing tramway systems. The great electric companies in Germany must, therefore, turn their attention to foreign countries with respect to the construction of tramways. As regards the supply of tramway material to existing tramway systems, a marked improvement is noted, due to the higher speeds necessitated by the increase in traffic, on account of which the number of tramway cars has to be augmented continually. On the other hand, a number of cars having one motor had to be fitted with two motors. To allow of existing tramway systems being continued to connect two neighbouring towns, as is largely the case in America, the prohibitory regulations in respect to Prussian small gauge railways would have to be modified.

* * *

***Note.**—Mr. W. M. Mordey's article, "Electric Traction for Railways," is unavoidably held over until our next issue.*

TRACTION NEWS IN BRIEF.

Electric Postal Vans. Electric postal delivery vans are making their appearance in Paris. Fifteen have just been placed in service, destined to collect the letters for the night mails. The guaranteed speed is 30 kilometers per hour. Trials made with the new type of van have been very satisfactory.

LIGHTING and Heating

Under this heading the development of lighting and heating by electricity receive all necessary attention. Apart from technical articles in relation to lamps and lighting, the merits of the various systems in operation, descriptive notices of conspicuous installations, records of new achievements, &c., are comprehensively and impartially described and illustrated.

* * *

A New System of Light Projectors.

By JOHN A. PURVES, D.Sc., F.R.S.E.

In the above title the word "Projector" is not to be interpreted in its narrow sense of "Search-light," but in its broader use, namely, that of an apparatus whereby light is projected from a certain origin in a given manner and direction. Such "Projectors," therefore, include Lighthouse apparatus, Light-ships, Beacons, Lighted buoys, Ships' lights, Search-lights, and even Street lamps. The new system about to be described embraces all these.

The application to lighthouse purposes will be considered first. It is probably scarcely necessary to say that a lighthouse apparatus consists of a central luminary or lamp, the light from which, falling upon a lens or reflector, is parallelised into a beam directed to the horizon; and, it is further hardly necessary to say, that the great object of the lighthouse engineer is to produce a light of the greatest possible power and the most marked characteristic consistent with economy. This end has been arrived at in modern lighthouse engineering by the employment of flashing light panels, of the greatest possible focal distance and amplitude (angular opening); by the use of an electric arc as an illuminant; and by placing two or more apparatus, either side by side or superposed, so that the emergent beams from the respective apparatus may, when the surfaces of the panels become punctual by distance, be homologated. Of such designs are the hyperradiant, the bi, tri, and quadraform apparatus, and, more recently, the twin lightning light apparatus adopted in France and elsewhere.

Now, it is clear that all these designs necessitate the increase in size of the actual light projecting apparatus itself, and, therefore, of the containing lantern, parapet, and even the tower itself. The other prime *desideratum* in

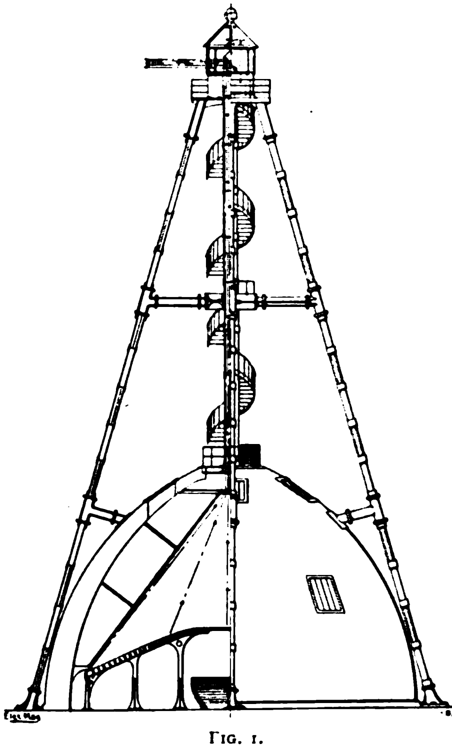


FIG. 1.

lighthouse engineering is to elevate the light to such a height as to be visible as far away as possible. The new system obviates the necessity of increasing the size of the actual light projecting apparatus and its attendant parts, and places within the reach of the lighthouse engineer the possibility of establishing lights of unprecedented power and efficiency in structures of moderate cost, no matter how great the elevation of the building must be.

In the new system there are three well defined optical parts or sections. These are, for the purposes of description, termed the *Generator* lenses, the *Collector* lenses, and the *Projector* lenses. From this fact the new system has been called the *Trioptical*.

The Generator lenses may, as in Fig. 1, consist of one large holophote, with a central illuminant. In the drawing this holophote is shown occupying a position immediately above the light. The function of the Generator lenses is not, as in the case of the usual lighthouse apparatus, to parallelise the light from the illuminant, but to converge it upon the Collector lens placed, in this case, immediately above, in what may be termed the vertical axis of the Generator lens.

The object of the Collector lens is to collect into one parallel and cylindrical beam the converging rays from the Generator lenses. This lens, after parallelising the rays, directs them upwards through the tower until they impinge upon the Projector lens, the function of which is to transmit the emergent beam seaward as desired. Such in brief, and in the fewest possible words, is the general description of one, and that a generic form of the new system as applied to lighthouses.

The apparatus and structure will now be considered in more detail; after which the advantages to be derived from the employment of such a system will be looked at.

Firstly, as regards the general structure and arrangement of the building itself. It will be seen at a glance that the old idea of lighthouse construction has been here abandoned altogether, and a new one put in its place. Instead of having the light-room and apparatus perched upon the top of the tower, where, of necessity, from structural and economical reasons, their size is limited to the smallest possible, these are placed at the bottom of the structure, where, if anywhere, ample space can be had without undue expense of construction. Having thus arranged by this form of design for the possibility of ample space in the light-room, it is clear that many limitations are removed which have, up to the present, hampered the lighthouse engineer. For example, the actual lighthouse apparatus which has in the past been limited to the hyperradiant of 1,330 mm. lenses, can now be enlarged almost indefinitely, and, when it is remembered that the power of a lighthouse panel increases as the square of its focal distance, the enormous power attainable under the new system is at once apparent. Thus, taking a rough example, it may be taken that a hyperradiant apparatus, consisting of a lens of 180° and 180° of mirror, will yield a light of 2,600,000 c.p. Now, should a Generator lens of 2,660 mm. focal distance be employed, the power of the light will be, roughly, 10,000,000 c.p., even after deduction has been made for losses at the Projector and Collector lenses; while, by increasing the focal distance two and a half times (3,325 mm. focal distance), the emergent light would have a power of 15,000,000 c.p.

The Generator lens itself is, as has already been said, a holophote, consisting of concentric annuli of refracting or reflecting prisms.

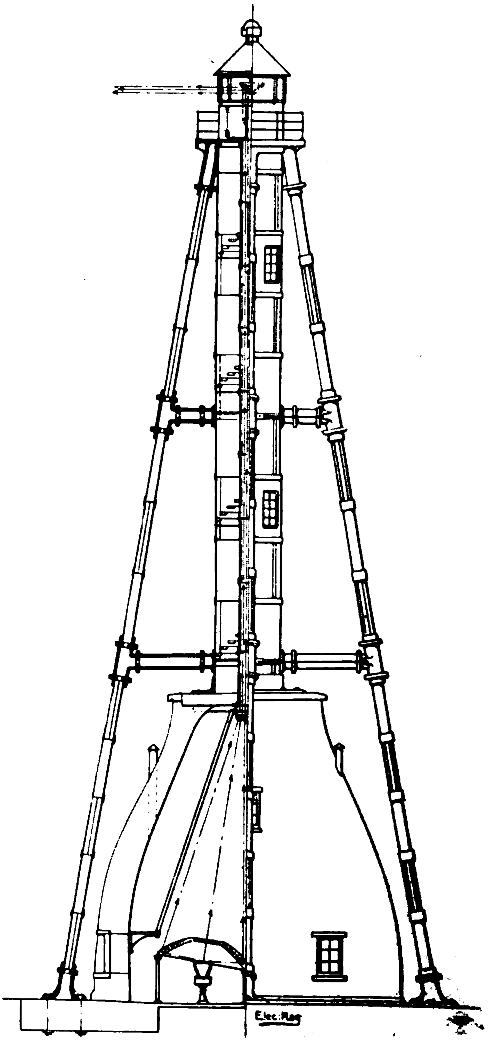


FIG. 2.

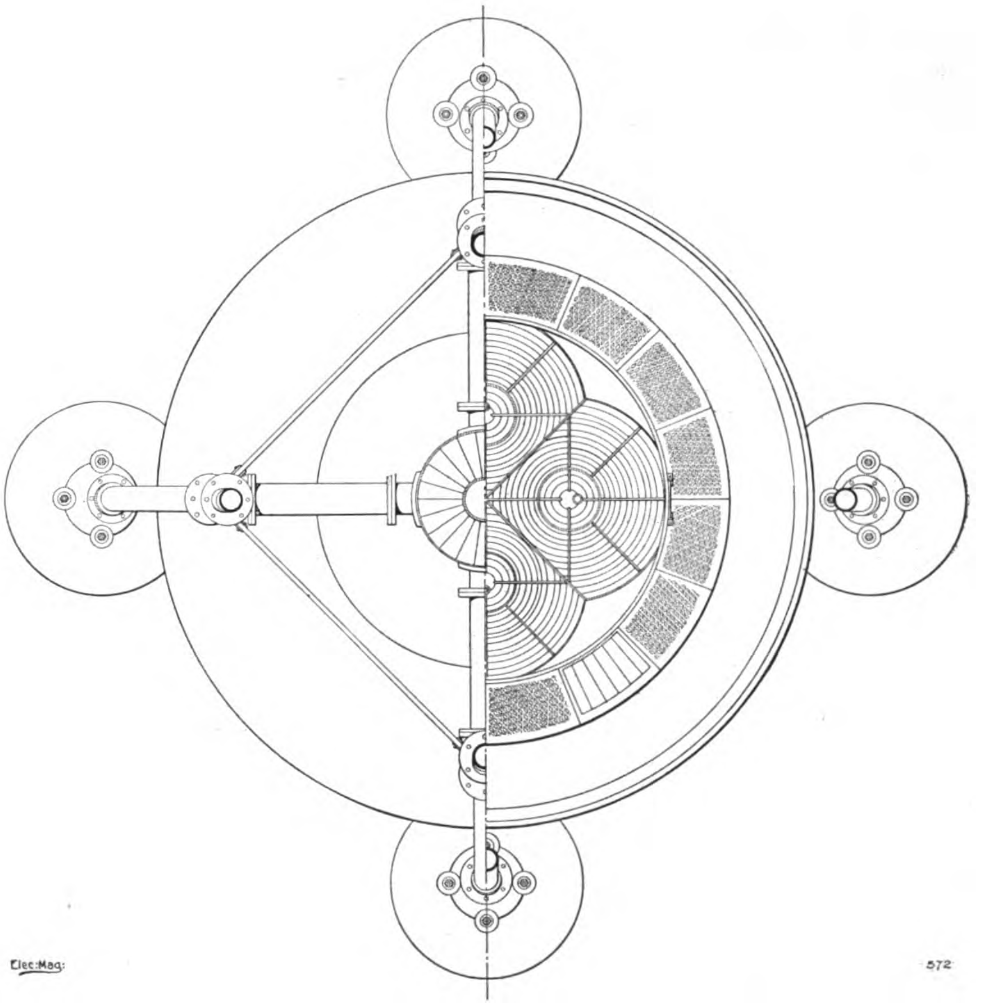


Fig. 3.

The cross sections of these prisms is such as to converge the light to an optical focus X, situated at a point above the Collector lenses. If preferred, this focus can be brought to a point below this lens, so that the rays will all cross and pass to the Collector in a divergent (instead of a convergent) cone. Further, it will largely depend upon the structural considerations whether this focus X is placed at a greater or less vertical distance from the lamp focus. In determining what this distance should be, it must be borne in mind that the longer the distance is, the less will be the amount of total deviation required for the rays emerging from the lamps, and, as a consequence, the smaller will be the loss due to ex-focal divergence, coloured dispersion, and surface reflection. The form of cross section of the lens elements of the Generator must be carefully considered in designing, for although the ordinary plano-convex or Fresnel section of refractor is shown in the drawing, and also the usual section of reflecting prisms, these will be found to be by no means the most efficient; indeed, the only form of lens that will produce satisfactory results is of the "Uni" type. For a description of the "Uni" lens, reference must be made to patent specification No. 21,848, of 1900. A few words may here be given to this form of lens elements, as there has been no description up to the present, except the specification referred to above. The principle of these lenses is, that, unlike other forms, the whole amount of refraction is done upon the first or inner surface in the case of the refractor, and, in the reflecting prisms, the whole of the work is done upon the first refracting surface and the reflecting face, the outer face being inoperative. From the fact that all bending of the rays is accomplished in the manner just described, it can be mathematically demonstrated that the ex-focal deviation (due to the size of the illuminant) is a minimum, and hence the emergent light is a maximum.

The Collector lens is a much smaller one, its size depending where it is placed in the cone of rays, and its function is to parallelise the divergent rays from the Generator in a vertically upward direction. This lens should also be designed on the "Uni" principle, making its lower surface of such concavity as to parallelise all the beams by refraction, thus leaving the upper surface a plane at right angles to the rays. In the case of a Collector lens placed beyond the outer focus, the lower surface will be convex; but here, again, it is desirable that all the refraction should be effected upon it. The light now to be dealt with has been got into the form of a cylindrical vertical beam, and it is now necessary (for lighthouse purposes) to convert this into a horizontal one. This is accomplished in the case of a fixed light (as shown in Figs. 2 and 3), by allowing it to fall upon the Projector lenses, which consist of a cone of reflecting prisms, the apex of the cone being downwards. By means of this agent it is seen that the cylindrical beam is transmitted all round the horizon after the manner of a fixed light. In the case of a flashing or group flashing light, the cylindrical beam is cut across diagonally by the mirror lens shown in Fig. 1. This mirror, by being rotated about a horizontal axis, causes the beam to flash round the horizon (see Fig. 4). It is clear, that were group flashes desired, these could be produced by suitably designing this revolving mirror. It is, however, much better to employ a system of eclipsers which will operate across the cylindrical beam, after the manner of the designs of Messrs. J. & W. Purves and Mr. Alan Brebner, as this allows the full and undiminished power of the beam. Under the new system, the most suitable form of eclipsing device is either to give the Projector mirror a periodic rotation about a horizontal axis, whereby its light will be dipped out of range, or to produce a similar result by dipping the Collector lens. There is still another method whereby a flashing light can be produced, namely, that illustrated in Fig. 5. Here it will be seen that the Collector lens is formed of two parts: the upper with facets running across the surface, so designed as to direct the rays, not vertically upwards, but at a slight inclination from the vertical. This inclined beam falls upon a Projector lens, consisting of an inverted truncated cone of prisms, and, in order to produce a flashing light, all that is required is to revolve the Collector lens upon a vertical axis, whereby the cylindrical beam is caused to travel round upon the surface of the truncated cone, from which it is projected seawards.

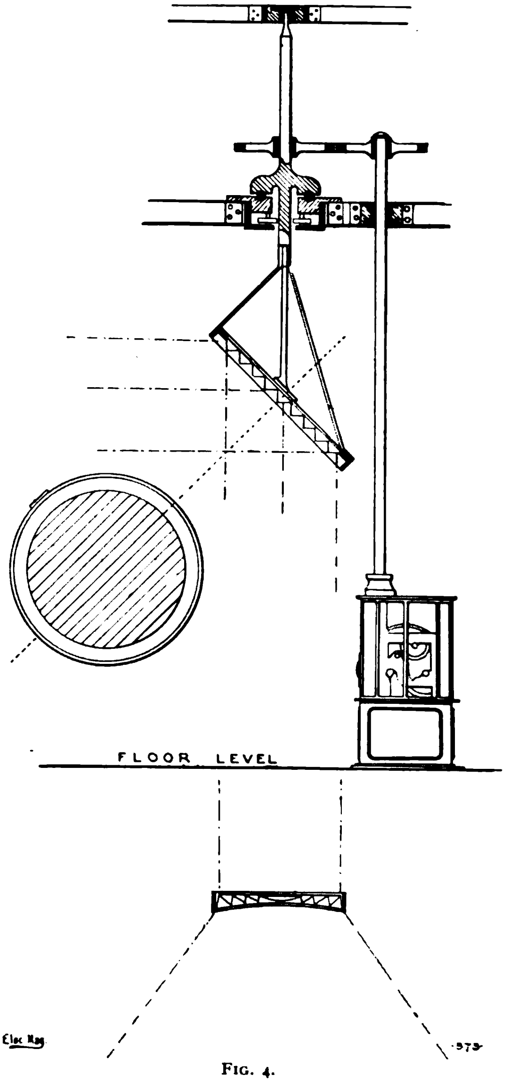


Fig. 4.

The employment of one Generator lens of great focal distance is by no means the only possible way of obtaining the desired end, for, as it is shown in Figs. 2 and 3, a plurality of lenses, each with its separate illuminant, can be employed. Here, as will be seen from the drawings, the Generator lenses have their focal planes inclined at such an angle from the horizontal, that the extreme inner rays (X, Y) coincide with the vertical axis of the tower and of the cylindrical cone of rays passed upwards from the Collector lenses. In this design it will be seen that six second order holophotes are employed, so cut away in plan as to have a common meeting point in Y. The result of such a combination of inclined holophotes is to produce from the surfaces of the entire group a cone of rays with a common apex at X. The outer surface of this cone consists of a series of circular arcs, which, however, do not in any way affect the general result, as the Collector lens in this case is made of such size as to embrace the full amplitude of the cone, on the supposition that its outer surface was such as to circumscribe all the arcs. If the illuminants were electric arcs of the same power as those used in the Phare d'Eckmuhl electric light, each panel would contribute, approximately, 81,000,000 c.p. to the beam, with the result that, were all six employed at once, the total emergent beam would practically have a power of 500,000,000 c.p., assuming the flashes to be single.

The lighthouse engineer has not yet exhausted the possible designs when he has contemplated the two forms of Generator lens just mentioned: to wit, the one with one large lens, and the one with six circumscribing lenses. For example, the large single Generator might be made, not on the principle of the holophote refractor, with dioptric elements, but it could be constructed after the manner of the old parabolic reflector, with (if desired) a holophote in front. Further, the number of separate lenses is quite immaterial. Two could be used with advantage, or more than six if it were thought necessary. Nor is it necessary to adhere to the placing of the lenses (many or few) upon the same floor level. Indeed, where an old lighthouse tower is to be metamorphosed, the system can be adopted wherein there is a Generator lens in each storey of the building, the light from which is caught up by the Collector lenses, and passed upwards through a central well to the Projector in the lantern.

The revolving mechanism for actuating the Projector lens can naturally be of the smallest and simplest kind, as the weight of the mirror is very small indeed. In the majority of cases, very simple ball bearings are all that is required. The same remarks apply to the case where the Collector lens is made to revolve; but here the matter is even simpler, owing to the whole mechanism being in the light-room itself.

As regards the lantern itself, all that is required, so far as size goes, is that it should be sufficiently large to admit the attendant for cleaning purposes.

Turning to the advantages to be derived from such a system, it is clear, in the first case, that practically unlimited power of light can be obtained. Such increased power of light is, moreover, gained, not in the most expensive manner. It is true that powerful and expensive lens panels are employed, but it must be remembered that these are fixed and not revolving, and that, therefore, the cost of a large revolving machine is saved, and, further, the cost of lantern accommodation is very little. It is, however, in the superstructure necessary to carry the light that the greatest saving can be effected. When it is considered what the cost of a tower must be to carry an 18 ft. lantern and light-room, it will be clear that a great economy could be effected by such a structure as that shown in Fig. 1 or Fig. 2. Indeed, under the new system, all that is required is such an openwork structure as will adequately support the small lantern required, and, at the same time, allow the attendant to get ready access thereto. The ease and rapidity of erection is also no small matter.

In a word, under the new system the power of the light can be enormously increased beyond anything now in use, at the expense of somewhat more costly dioptric and catadioptric apparatus, but with great saving upon towers, lanterns, and revolving machines.

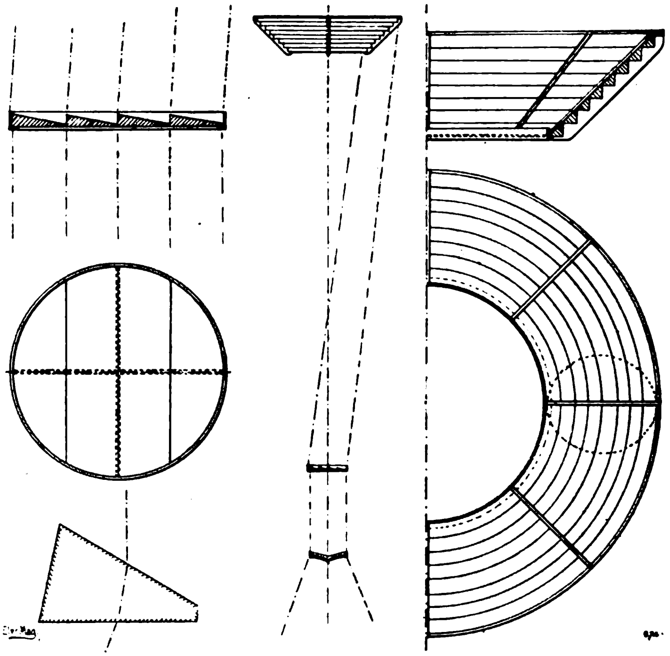


FIG. 5.

There is also this advantage, that the most expensive and precious part of the lighthouse apparatus is in a safe and secure situation; not, as now, in a glass lantern of large size upon the summit of a high tower. The lantern, such as it is, is small and compact, and no one needs to constantly abide in it. The guardians of the sacred fires can now work in comfort in a more secure, if less exalted, sphere.

It may be said that the Trioptical system, as applied to lighthouses, is preferably worked in conjunction with such illuminants as incandescent burners and electric lamps, rather than the ordinary paraffin burners; and on account of the lamps being placed in the lower part of the lighthouse or other structuie, greater facilities are offered for the installation of the two first-named illuminants. Indeed, to ensure efficiency from the Trioptical system two points must be borne in mind: (1) The burners should in no case produce a divergent cone upon the surface of the Generator lens with a larger angle than 2 degs.; and (2) that the lens elements should all be of the "Uni" type, so that the divergence produced by the burners will be reduced to a minimum.

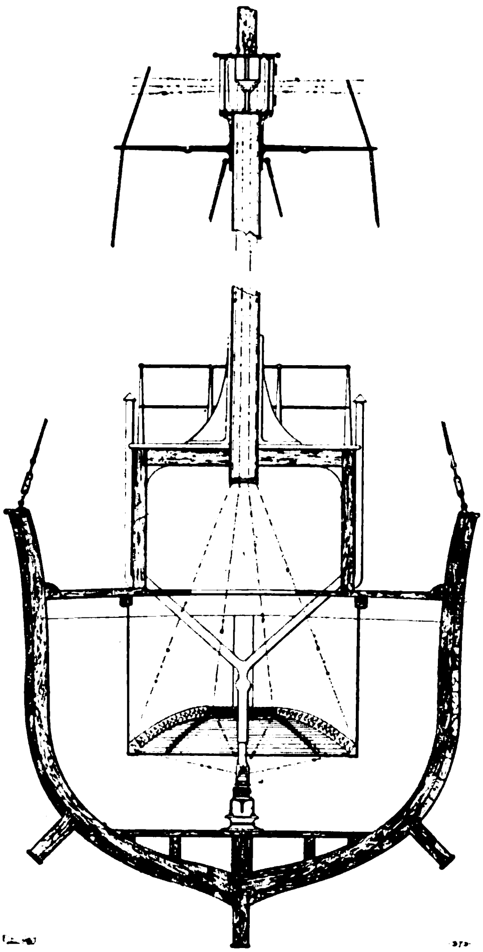


FIG. 6.

From what has just been said, it is clear that this system is peculiarly adapted for lightships (see Fig. 6). In their case the light-room is in the hull of the vessel, where safety and plenty of space for the most powerful Generators can be had. The Collector lenses are placed immediately below the hollow mast, up which the light is transmitted to the Projector lens or lenses in the small lantern on the mast.

The same remarks as to the production of fixed, flashing, or group flashing lights applies equally to the case of light-ships. Fig. 6 illustrates the application in the case of lightships.

The invention is also applicable in the case of lighted buoys, and in its application to them much more satisfactory results can be obtained. In buoys, the central part of the buoy can be formed into a chamber wherein the Generator lens is contained. As in buoys the vertical distance between the Generator lens and the Projector lens is necessarily short, the interposition of a Collector lens can be dispensed with, as the Projector lens can be placed so near the outer optical focus of the Generator lens that the divergent rays can be dealt with direct, being parallelised vertically by contact with the first glass surface, after which they are transmitted seawards by the action of the remaining reflecting faces of the prisms.

Indeed, in all cases where the vertical distance between the Generator lens and the Projector lens does not need to be great, the Collector lens can be dispensed with, as by placing the Projector comparatively close to the focus the desired results can be obtained. In a street lamp designed after this system the same remarks apply. Again, the Trioptical system can be used with advantage for illuminating the mast-head and side-lights of a ship. When applied to such a purpose, the lightroom is provided below, and from the Generator lenses contained therein the beams of light are transmitted by suitable Collector lenses to Projector lenses placed at the masthead and side-lights.

The application of the new system to searchlights and Projectors will also be apparent, and on ships of war its advantages must be very clear. On such vessels, the light-room containing the Generator lenses can be placed in some safe part of the ship, from which the Collector lenses transmit the beam to a simple mirror Projector, mounted on an arrangement of trunnions capable of giving it the required direction. Should this mirror be damaged in any way, it could easily be replaced at a few moments' notice, while the vital part of the apparatus—the Generator lenses—remains in safety.

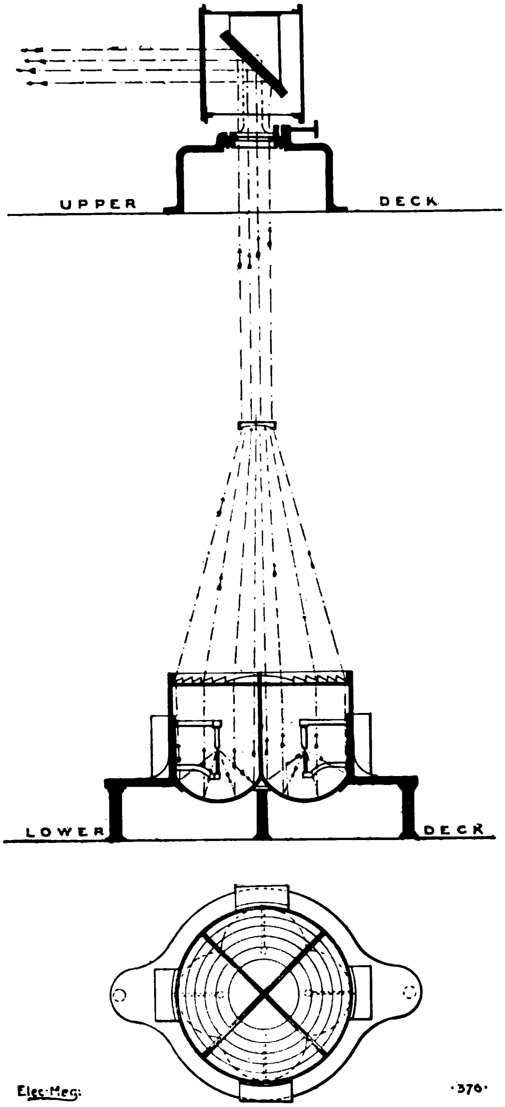


Fig. 7.

Fig. 7 illustrates the Trioptical system as applied to Projectors. From the drawing it will be seen that a group of four fixed Projectors are mounted below the deck in the case of ships, or below the ground in the case of forts. The Projectors in plan are seen, not to be circular, but to form sectors of one large circumscribing circle. The usual parabolic mirrors are used for parallelising the light, while at the front a dioptric Generator lens is placed, whose function is to direct the rays upon the Collector lens above, from which it is thrown upwards upon the Projector mirror.

No attempt has been made to give the mathematical and optical reasoning and investigations of the various lens elements, nor of the effect of these upon the rays.

All this, although it has been fully considered and worked out, is scarcely suitable reading for any place but the pages of a purely mathematical journal.

THE TESTING OF LAMPS.

A great deal of talk goes on from time to time about the rating of incandescent lamps, and from papers written by manufacturers the outsider is bewildered by the intricacies of testing devices which are said to be applied. If the papers by the expert manufacturers are to be believed, any filament which does not come up to the highest standard is at once rejected, and by careful examination all the lamps are sorted out, so that they are distributed to the consumer after careful adjustment as to candle-power, efficiency, and the like. In the face of all this, we are brought up by the statement of one of the speakers at the Iowa Electrical Association that he did not know of a single manufacturer who sent out lamps of nominal 16 c.p. which did not vary at least 1 c.p. either way from this rating. This probably tallies with the experience of anyone who has had a photometer in his hands for a few hours, and emphasises the necessity (which is well recognised in this country) of having a lamp testing department in each central station; but even this will not protect the consumer who supplied his own lamps, buying generally the cheapest variety. Even if he were to buy the most expensive variety, he would not necessarily serve his interests any better in so far as rating of lamps is concerned. In spite of all that has been said and written on the subject, a very little experience is all that is necessary to teach us that a lamp rated at 16 c.p., at a given voltage, may give anything from 12 to 20 c.p. in point of fact, and that the speaker above quoted can be said to have taken the most favourable possible view of the matter. The 16 c.p. can only be right if the voltage is altered, and the voltage can only be right if the candle-power is altered. In practice, the voltage is only altered by circumstances beyond the control of the consumer. For the purposes of this argument, it may be taken as invariable; therefore, the candle-power is the variable. And even if the candle-power can be told from the frosted bulb, with a liability to error of, say 25%, what sort of information has the consumer with regard to the efficiency? He takes this on faith, knowing nothing. Probably he thinks that all lamps have the same efficiency, and ignorance is bliss. Unfortunately, we do not see any way of escape, unless an action can lie against a maker who supplies a lamp with a wrong voltage or candle-power frosted upon it. The result of the first successful action would be to raise the price of lamps to an enormous extent; the lawyers, as usual, would be the only people to make any money, and the last state of the consumer would probably be worse than the first. Probably the best thing would be for the makers to take some action among themselves; but this proposal sounds too quixotic to be practicable.

LIGHTING AND HEATING NOTES.

Street Lighting by Nernst Lamps.

We have in recent numbers pointed out that a great future for the Nernst lamp will probably lie in street lighting, and users have by this time had sufficient experience to warrant the publication of their results. Mr. Joseph, who reports from Hythe, is one of the well satisfied kind. According to his experience, provided the voltage is reasonably steady—*i.e.*, does not vary more than 5% in all, or 2½% either way—the average life of the burners is almost as long as that of carbon filaments. Both ½ ampère and ¼ ampère lamps are used. The first batch of ¼ ampère lamps had an average life of 493 hours, there being 86 in all. This shortness of life was due in part to the fact that some of the lamps were inserted with the wrong polarity. The next batch of 30 had an average life of 1,345 hours. These lamps are the equivalent of a batswing burner, and the ½ ampère lamps, which replace Welsbach burners, had an average of about 750 hours' life. The latter type of Nernst lamp is recommended for use in street work; the smaller variety is only a very slight improvement on the old batswing burner, and it is evident that our ideals call for a higher standard of efficiency than one which has been already discarded by the gas world.

Electric Lighting in Southwark.

Places like Southwark are in the forefront of the fight between gas and electricity. Here, considerations of health, cleanliness, and pure atmosphere are possibly matters of abstract importance. On the other hand, the flare of gas lamps and naphtha burners can be translated into the concrete in the shape of an accumulation at the bank. Probably the whole thing is a matter of pounds, shillings, and pence—nothing more nor less. But in Southwark the installation of electric light has little advantage from the point of view of advertisement, far less than in the case of Bond Street. We regret, therefore, to find that there seems to be some reason to suppose that the electric lighting concern which is owned by the local Council is going through a time of storm and stress. Most of the storm seems to fall on the head of the resident engineer. He complains that even consumers, who can get current at 3d. per unit, are reverting to gas, though this is not within his own experience, but in that of an engineer supplying current in a neighbouring borough. Either there must be something unsteady about the light supplied, or we have not yet reached bedrock in a matter of prices.

Increasing the Output of Central Stations.

The experience of our American cousins can often be made to teach us useful lessons. Mr. Zahm, of Mason City, recently read a paper before the Electrical Association at Iowa on the above question. He believes in the maximum demand system, but would make exceptions in favour of churches and theatres, because their time of maximum demand does not generally coincide with the peak at the central station. The suggestion is also made that a demand might be created in the direction of public and private pumping plants, in the operation of refrigerating machinery, and for heating devices and sign lighting. Ice in one form or another seems to be a useful auxiliary to the American electrical engineer. Thus, besides creating ice by means of refrigerators, at another time of the year he makes money by thawing out frozen pipes. Though this latter does not bring in a very large income, it is fairly easily earned, and the work done would cost a great deal more if it were done in any other way. The charge is about £2 10s. for the first hour, and £1 5s. per hour after that. The rough rule in these cases is to use half a volt per foot of 2 in. pipe, increasing the voltage inversely as the square of the diameter and directly as the length.

American Experience with Nernst Lamps.

At the Iowa Electrical Association a discussion arose on the Nernst lamp in practice. The verdict was generally favourable; the deficiencies noticed were generally such as arose from circumstances inherent to electric lighting systems generally, and tended to show that the lamp is at present not possessed of a sufficiently strong constitution to resist great changes of temperature. Put briefly, it all amounted to the fact—already well known, for that matter—that the Nernst lamp cannot withstand any great increase of voltage for any considerable period, and that very close regulation is necessary. It is said that a filament will stand about the same variation of voltage as a 3·1 watt incandescent lamp, which looks well. On the other hand, another speaker said that the cost of maintenance was about one farthing per kilowatt hour supplied to the lamp, and this looks heavy. Another speaker said his main difficulty had been in connection with the burning out of the heaters, since the customer did not switch off the lamp when the filament burnt out. But a very short experience on the part of the consumer will rectify this, and it is satisfactory to be able to report that the lamp is making headway in the United States.

A Portable Miner's Lamp.

The Neu-Catrice lamp was introduced to the notice of the mining fraternity at a recent meeting of the Institution of Mining Engineers. It has small accumulators, two cells in all, and the electrolyte is contained in such a way that the lamp can be held in any position without spilling the fluid. Small charging plugs are provided, and the lamp can only be lighted when a small shutter—connected with the switch—is closed and the charging plug withdrawn. In one size the whole apparatus weighs rather less than 4 lbs., and gives 0·8 c.p. for 11 hours; a larger size weighs 5 lbs., and gives 1 c.p. for 15 hours. A special charging table is used, on which the lamps—connected in series—are charged daily by the colliery dynamo. The cost of maintenance has been found, at the Bruay collieries, to amount to one halfpenny per lamp per diem. The total working cost of electric mining lamps has been found to be three shillings per lamp per annum more than that of the ordinary oil lamp; but this does not seem to be a high price to pay as an insurance against explosion in mines, more especially in cases where the atmosphere is dangerous.

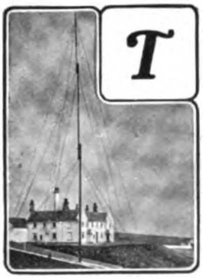
TELEGRAPHY & TELEPHONY

Telegraphic and telephonic matters have not hitherto received that amount of attention by the technical press of this country which the importance of the subjects warrants. In this section much of value that would otherwise be missed will be published, and apart from independent technical articles, progress both by land and sea will be faithfully recorded. The section has for its Associate Editors, leading men in the telegraphic and telephonic spheres, who for specific and sufficient reasons desire to preserve their anonymity.

* * *

High Speed Telegraphs.

By E. O. WALKER, C.I.E., M.I.E.E.



THE Baudot telegraph is likely to have an extended sphere of usefulness by the improvement applied by Dubreuil. This inventor has made a searching enquiry into the expense of construction, equipment, and maintenance of an ordinary telegraph circuit, and the expense of the staff employed to work it, and has compared the figures thus obtained with those pertaining to a circuit worked with Baudot multiplex telegraph. He comes to the conclusion that the results of this investigation are not so favourable to multiplex systems as might be supposed, owing to the large cost of the operators concerned. This consideration has led him to seek means to increase, within the present limits of time occupied, the rendering of the apparatus. If the sending instrument were furnished with 10 keys in two groups, and it were practicable for one operator to deal with that number of keys, it would be possible to obtain 1,024 different combinations, but experience showed that the operator could not for physiological reasons accommodate himself to 10 keys. Dubreuil has therefore adopted 8 keys in two groups of 5 and 3 respectively, and permitting of 256 combinations. The simultaneous depression of two keys belonging to different groups with appropriate translator allows ot the union of two letters which can be registered during the time of revolution of the brush of the distributor. Dubreuil calculates, by introducing this alteration into the Baudot apparatus, to increase the rendering for each operator almost two fold. The angle occupied by the sector on the distributor is augmented in proportion to the increased number of keys. It is in connection with the appearance of an account of this improvement in the *Revue Internationale de l'Electricite* that Mr. A. de Grandmaison subsequently described his device patented in November, 1900, to which reference was made in the issue of April. He then introduced a sixth key, to supplement the five existing in the Baudot, as has been already stated, this key serving to send the spacing signal. To apply the system to the Baudot translator, the inventor employs the electro-magnet E (Fig. 1), joined to the sixth sector, which when it receives the current due to the sixth contact, hinders the finger M shown in the figure from engaging with the projection on the cam C, which permits the paper to be unrolled for the requisite interval to produce the space. Again the printing

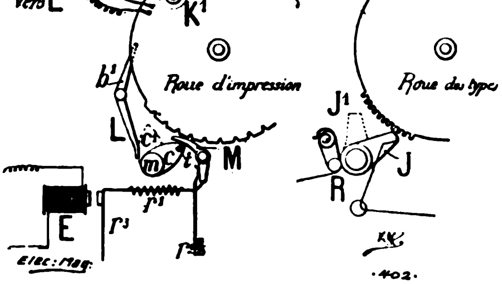


FIG. 1.

arm is brought a second time into the proper position for making an impression by the boss K, when it comes into contact with the arm I^1. The results obtained do not claim to be so extensive as those of Dubreuil.

THE MERCADIER MULTIPLEX TELEGRAPHY SYSTEM.

This invention has been recently improved and tested in England and America with very satisfactory results. The ordinary Morse system allows of 17 words only per second being sent on one line and in one direction, the Baudot quadruplex provides for 84, while with the Mercadier, 12 telegrams can be sent simultaneously in either direction, or 204 words per second in one direction. The invention is based on the well known law that alternating currents of different periods may flow simultaneously in the same circuit without interfering with each other, the resultant current in the wire being simply the sum of the several component currents. In the apparatus, currents are utilised having 12 different frequencies, which correspond respectively to those of pure musical notes. The receiving apparatus, or monotelephones as the inventor calls them, are so constructed that the diaphragm of each vibrates only in one particular way, emitting one sound only. Each monotelephone therefore picks out and resonates to the particular current which has the same period as itself. The range of musical notes adopted for these instruments extends from B to A, and an interval of one semi-tone between neighbouring notes has been found by practice to be sufficient for discriminating between the signals. In order that transmission may be realised in either direction on any line, the transmitting apparatus of the same station must work independently of each other, and the method adopted for this end by the inventor is both simple and ingenious.

The transmitting apparatus consists of a tuning-fork excited by an electric magnet (Fig. 1) placed between the prongs, and in circuit with cell P. One of the prongs bears a make and brake device, and the whole behaves like an electric bell. The number of breaks per second, or the frequency of the variable current is equal to the number of vibrations of the fork. This is verified experimentally by the fact that a telephone shunted on the circuit emits the same sound as the fork. The currents utilised on the line are generated in the secondary circuit.

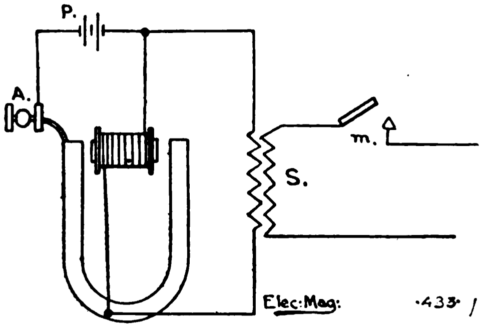


Fig. 1.

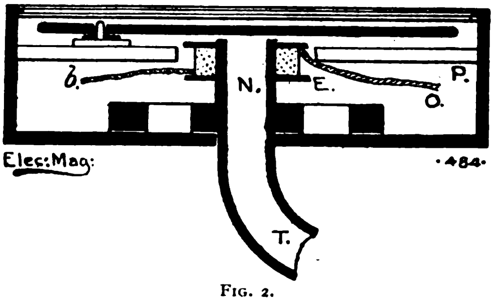


Fig. 2.

The monotelephone is the outcome of long and patient investigation by the inventor on the vibrations of metallic blades and plates. Any plate of suitable thickness emits a fundamental sound of well defined harmonics, like a rod or a stretched string, according to the manner in which the plate is held. M. Mercadier has found that a pure sound is emitted only when the thickness of the plate is at least equal to 1 mm.; the number of complete vibrations in a plate of thickness e and diameter d is given by the formula $M = k\frac{e}{d}$, k being a function of the elasticity and density of the metal. The monotelephone (Fig. 2) is constituted by a telephonic metal diaphragm, 2 mm. thick, resting on three points of the circumference of the first nodal line, the radius of which is equal to $\frac{88}{100}$ of that of the diaphragm, this latter radius being determined by the condition that the sound chosen for the instrument be the first harmonic. This is placed in a cylindrical box having a glass cover, and containing a powerful magnet, the hollow core of which is surrounded by a bobbin E, just like an ordinary telephone. The sounds are heard through an acoustic tube T, fitted to the hollow core and having ebonite terminals which are placed in the ears. The line currents are first taken to a special winding which will be described hereafter, and which reacts on the bobbin of the monotelephone.

The same station must, of course, both transmit and receive messages through the same line circuit, and the great difficulty which M. Mercadier had to solve was to secure the complete independence of the receiving and transmitting apparatus. In Fig. 3, b and b^1 are primary windings inserted in the receiving and transmitting circuit respectively. Windings c and c^1 together form part of an extra or "dummy" circuit containing

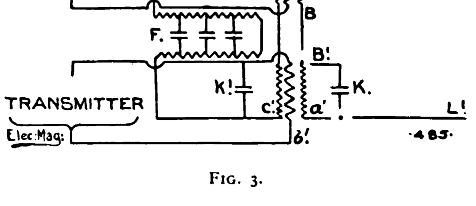


Fig. 3.

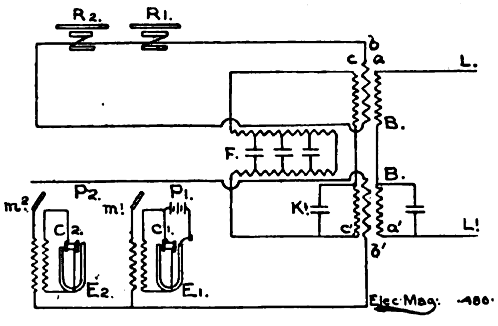


FIG. 4.

variable impedances, and a and a¹ are on the line. Thus transformers B and B¹ have three F windings each. When a message is being sent the currents set up in winding b¹ act on c¹ and a¹, the induced currents of which, flowing respectively in c and a, neutralise their individual effects on winding b, if the impedances in F and the condenser K are suitably adjusted. Thus the currents set up in a¹ can be transmitted through line LL¹ without disturbing the receivers. The connections are the same when several transmitters and receivers are used. Fig. 4 shows the line fitted with two receivers and transmitters.

The next difficulty was to provide means for ringing up any station when required. Two cases may arise in actual practice: (1) Two stations only are on the line. Continuous current may then be used for calls, care being taken to insert a choke-coil so that the signals may not interfere with the periodic currents. But in this case calls are practically superfluous, as when two stations only have the monopoly of the line, the exchange of telegrams will probably be continuous. (2) Several stations are distributed on the same line. It would, in this case, certainly be interesting to find some means for ringing up any station without disturbing the others. Nothing practical has yet been found, and this is the drawback of the system. It may be argued, however, that calls are not indispensable, as the noise in the monotelephones is sufficient to attract the attention of the attendant, if he be not more than 2 metres away from the apparatus. Such as it is, the Mercadier system solves the problem of multicommunication on one line in a very simple and original fashion.

* * *

THE MAGNETIC DETECTOR.

ALTHOUGH some remarkable results have been achieved with the Marconi magnetic detector, little in the way of actual experiments with the same has been published beyond those of Tissot, which deal mostly with comparative tests and distance trials.

Mr. A. L. Foley has, however, recently read a paper before the American Association for the Advancement of Science, on the use of nickel in the core of the revolving magnet type of Marconi detector. In his experiments, Foley used a ballistic galvanometer in place of the telephone, and took readings for various positions of the magnet and core. The core was made of 26 pieces of annealed piano wire ·063 centimetre diameter, 5 centimetres long, the demagnetising coil having 200 turns of No. 36 wire, and the galvanometer coil about 1,000 turns of No. 30 wire. The demagnetising coil was connected to a vertical wire, 2 metres long, and to earth respectively, and a similar aerial was used at the transmitter with a 1 inch spark coil, the distance between transmitter and receiver being varied from 2 to 20 metres, and the circuits being untuned.

Four sets of readings were taken—

(1) When the magnet was placed 10 centimetres from the core and moved one space *nearer* after each reading.
(2) With the magnet in contact with the core, but moved *away* after each reading.
(3) When the magnet was removed after each reading, and the transmitter worked before the magnet was shifted again.
(4) When the field was reversed (magnet turned round) between the readings.

The curves reproduced in Fig. 1 show that under (1), (2) and (4), deflections of very different values were obtained at a maximum common to all, about ½ centimetre separating the magnet from the core; (2) gives a much smaller maximum at distances from 2 to 4 centimetres. Thus, when the magnet is near the core, the detector is more sensitive when the magnet is *approaching*, and when some distance away, the detector is more sensitive when the magnet is *receding*. Removing the magnet and working the transmitter tended to demagnetise the core (Rutherford effect); on bringing the magnet back and working the transmitter, a larger effect was obtained; and finally, by reversing the field the greatest effect of all is obtained.

The effect of nickel was then tried, as, owing to the greater susceptibility of nickel to weak fields and the less susceptibility in stronger fields, it was hoped it would produce a more uniform sensibility. Cores were, therefore, made of steel wires only; of steel and nickel wires in equal number; of 13 nickel with 2 steel wires, and of 14 nickel wires only. The curves plotted from the results obtained with these cores show that the sensitiveness is about the same with the all nickel, as with the all steel core, though, contrary to expectation, it was greater in strong fields with nickel, and in weak fields with the steel, the all nickel core being more sensitive than the steel core up to 2½ centimetres distance. The mixed core, however, as will be

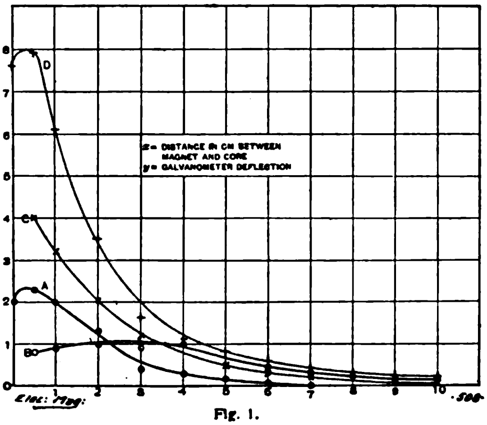


Fig. 1.

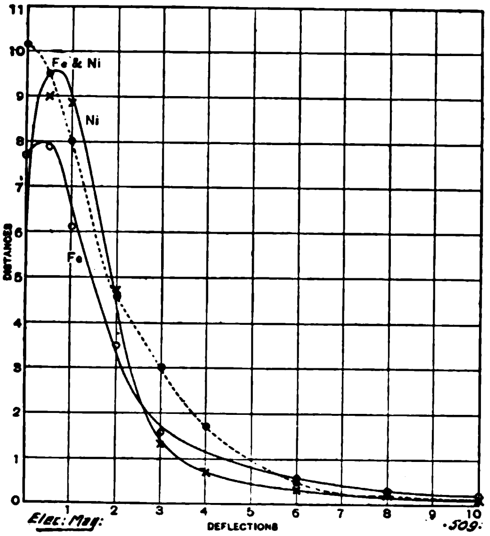


Fig. 2.

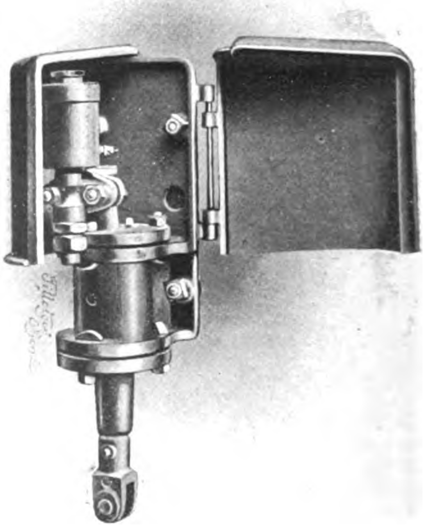
seen from Fig. 2, gives not only larger deflections, but these increase up to the point of the magnet touching the core; thus the mixed nickel and steel core is the most sensitive detector. It is considered that the frequency and intensity of the oscillations, and the annealing of the steel wires, would probably affect the form of the curve, and the author of the paper is about to try the effect of oscillations on the hysteresis loss of transformers and armatures, etc., since they appear to "have the power of reducing the effects of magnetic hysteresis."

ELECTRO-PNEUMATIC SIGNALLING.

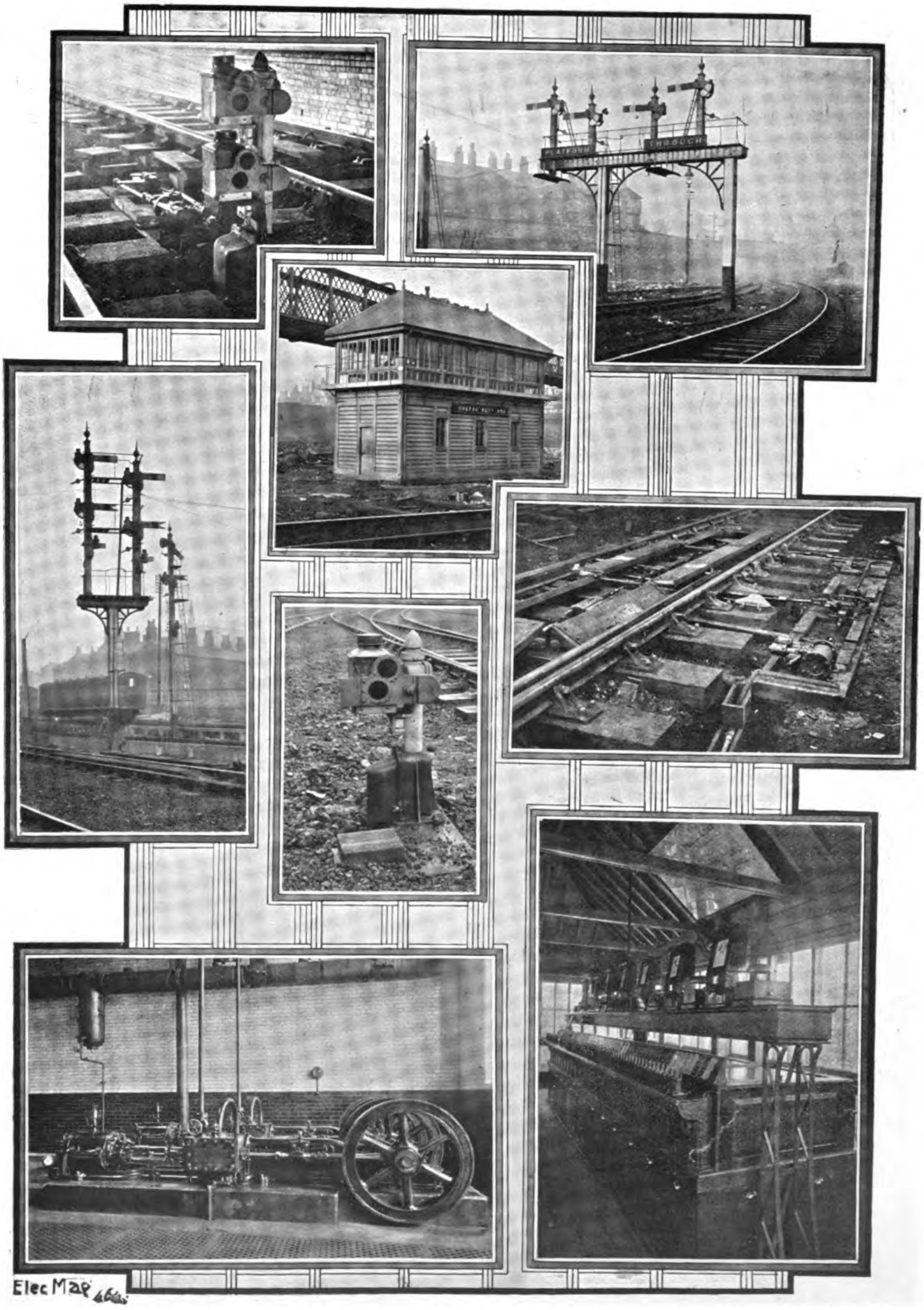
The encroachment by electricity upon recognised methods of signalling is becoming daily more clearly emphasised. Engineers have not been wanting in the supply of such electrically-operated apparatus, but railway companies have not been correspondingly anxious to adopt such proposals until quite recently. Accelerated service, increased goods traffic, and the reduction of the human element to a minimum, are among the chief factors responsible for the change, and power signalling should, as a consequence, now receive encouraging support from all progressive railway organisations. On the opposite page we illustrate a typical installation by the Westinghouse Brake Co., Ltd., for the Lancashire and Yorkshire Railway Co.'s Bolton passenger station. The system employed is now becoming widely known, consequently, we need only touch upon its chief features. In principle, compressed air, at 55-65 lb. per sq. in., is used to operate the signals and points, the air supply being entirely governed by electro-magnet valves, energised from a battery source, and controlled from the signalling cabin by suitable switches on a locking frame. A pipe line distributes the air to the signals and points, and cables, laid in wood troughs filled with pitch, conduct electrical energy to the magnet valves. The air before entering the main is passed through a surface condenser to extract all the water possible, and all reservoirs are regularly blown out to clear residual moisture, of which, however, there is very little. The signal and point motors are single and double acting respectively — the cut below depicting one of the former. The magnet valve is inside the box above the motor, the piston rod of which projects downwards. The composite illustration depicts the signalling frame, air compressing plant, several forms of signals, and the point motors. All signals are electrically lighted from the railway company's own station, where the battery furnishing energy to the magnet valves is also located. A current of 3·6 ampères at 14 volts suffices for the whole installation. There are 123 signals, 287 points, and 19 bars. The locking frame is 18 ft. long by 3 ft. 6 in. wide, and it is worth noting that two mechanical frames of about 56 ft. would be required to do the same work. Space will not permit of the production of diagrams or particulars regarding the interlocking devices introduced, but we can vouch for their extreme simplicity. The reliability of the system is evident when such companies as the Great Eastern, North Eastern, Lancashire & Yorkshire, and Metropolitan District have adopted it wholly or in part on their lines. We are indebted to the Westinghouse Co.'s Publishing Department for the illustrations reproduced herewith.

THE TELETEROGRAPH.

This apparatus, devised by Sr. Steno Larmonica, provides a means of telegraphic transmission which has the advantage of only requiring a small number of cells for long distance work. The transmitter (v. station S, fig. 1) comprises a key M,



Electro-Pneumatic Signal Motor.



ELECTRO-PNEUMATIC SIGNALLING INSTALLATION, L. AND Y. STATION, BOLTON.
(The chief items of interest in the plant are depicted above).

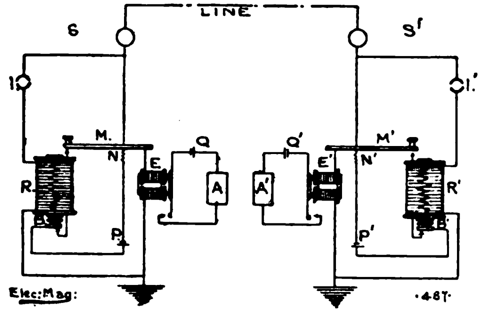
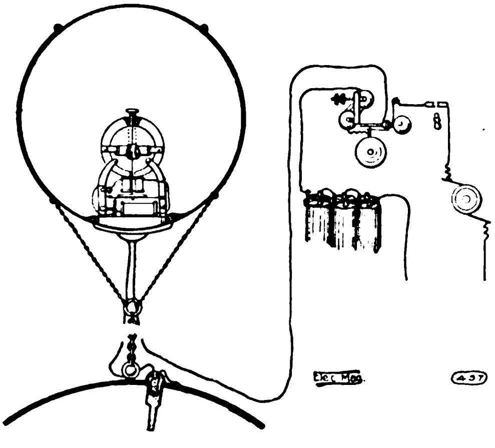


Fig. 1.

cell P and rhumkorf coil R whose primary is in series with M and P through trembler. One end of the secondary is earthed, the other being connected to the line through switch I and telephone T. The receiver consists of a relay, sensitive enough to respond to the weakest currents on the line, whose armature closes a circuit comprising a local battery Q^1 and Morse apparatus A. I is turned on during transmission, and off while receiving. The peculiar noise heard in telephone T^1 when a current is flowing in the line may be utilised as a calling signal. Pressing down Key M gives rise to an intermittent current in circuit RBPN, the secondary induced current, generally very irregular, being sent on the line to station S^1, where it flows to earth key M^1 and relay E^1. The armature of E^1 which is too inert to keep in step with the current oscillations, remains fixed and produces in A^1 a signal of the same duration as the one originally produced by M. With this system, telegraphic communications may be realised with high-pressure currents, and small sections of wire may be used for long distance transmission.

SUBMARINE MINES.

The extended use, by both belligerents in the far East, of submarine mines, lends added interest to a short article on the subject, which recently appeared in the *Scientific American*.



Electric Contact Submarine Mine.

The adjoining diagram, taken from our esteemed contemporary, depicts a ground mine with electric contact buoy and indicating apparatus for the shore station. The mine, usually a hemispherical metal case, contains several hundred pounds of high explosive, and rests by its own weight on the river or sea bed. Anchored to the mine and floating above it, is a hollow buoyant sphere containing the circuit closing apparatus. This comprises a circular magnet within which is a ball. Through the ball passes a cord hung at one end to the top of the magnet and attached at the other end to an armature. The armature is fitted with contact tips which close signal circuits to the shore and indicate which mine has been struck by dropping an indicator. At the same time the circuit through the firing fuse is completed. When the sphere is struck, the cord draws up the armature and sends the signal ashore by means of the local battery (seen on the right). The attendant in the station then closes, finally, the firing circuit, by inserting the plug which couples up the firing dynamo on a larger battery with the fuse. The mine then immediately explodes.

TUNING THE ANTENNA.

A simple method of attaining resonance in oscillatory circuits, as well as some effective lecture experiments, are described by Mr. A. H. Taylor in *The Physical Review*. To obviate any change in the capacity, and consequently of the period, the insertion of any device above the secondary of the jigger is avoided, a short piece of platinum wire being placed in the earth connection, the wire itself forming one arm of a Wheatstone bridge; readings are taken with a galvanometer of moderate sensibility.

When the transmitter is worked, a certain deflection is obtained, and then inductance is added to the aerial above the secondary. If the galvanometer does not give an increased deflection, the period of the secondary is already slower than that of the primary. A smaller aerial or a longer period in the primary is then required. Using the latter alternative, by varying the inductance, resonance can be obtained, and the deflections are then often one hundred times as large as when the aerial is far out of resonance.

Having tuned the aerial to the primary, a second primary is now tuned to the first by making a second jigger with secondary as near as possible of the same self-induction as the first. This jigger is then tuned to the aerial by adjusting the self-induction of the primary, as in tuning the aerial to the primary. The second primary is now removed to the receiver station, and a new aerial tuned to it; thus, there are now two primaries in tune with each other and with the aerials.

As a lecture experiment, the resonance of an oscillatory system can be shown by placing a small 1 c.p. 4-volt lamp in the aerial, or in the primary circuit of the jigger. With a distance between transmitter and receiver of 20 ft., and a spark coil supplied with alternating current (about 600 watts), a power factor of 0·5 can be obtained when the transmitter aerial comes into resonance, and if the aerials are of wire netting 10 ft. by 2 ft., the lamp will burn brightly and steadily as long as the transmitter operates, if the circuits have first been carefully tuned: on putting either aerial out of tune, the lamp goes out.

To obtain the values of the currents in the aerial, the platinum wire on the earthed side of the receiver was replaced by the lamp, and the bridge balanced. The current, measured by a hot-wire voltmeter of known resistance, was sent through the lamp, reducing its resistance and consequently deflecting the galvanometer. The lamp was now replaced in the aerial and the deflections observed as the self-induction in series with the aerial was varied whilst the transmitter was working continuously. A number of resonance curves, obtained with various self-inductances by this method, are then given in the paper, and these show very clearly how the resonance is, as is known, much sharper towards excess of self-induction in the circuit.

REPAIRING MULTIPLE JACK TROUBLE.

ONE of the most delicate tasks that the telephone switchboard man of to-day has to do is that of repairing or clearing a fault in a multiple jack strip of a telephone switchboard. The accompanying illustration shows the back of a large multiple switchboard and a switchboard troubleman in the act of clearing a fault in one of the multiple jacks. The layers are multiple cables which rest loosely, one on top of the other.

The multiple cables are those which contain the conductors, continuations of the subscribers' line wires, and taps from them terminate in jacks on the face of the switchboard. To make any subscriber's line available to any telephone operator for connection, these jacks are placed regularly, or *multiplied* at such intervals along the switchboard's face as to make it possible for any operator to reach any subscriber's jack.

Taps from these cables are soldered to the multiple jacks in the face of the switchboard. If a tap becomes detached from a jack spring to which it should be soldered, or any other faults develop "*in the multiple*," the cables are forced apart carefully, with wooden wedges, and the repairman, with special tools, either resolders the detached conductor or effects any other necessary repair. The apparatus is so delicate that, unless the individual is very familiar with his task, he is likely to make more "*trouble*" while fixing the original fault. Below the layers of multiple cable are seen the cord terminals and portions of the cords, or duplex conductors, used to connect one subscriber's line with another.

REPAIRING MULTIPLE JACK TROUBLE.

A UNIQUE RECEIVER PRINCIPLE.

J. W. LATTIG and Charles L. Goodrum, of the United Telephone and Telegraph Co. of Philadelphia, while making some experiments to demonstrate the heating effect of electric currents in conductors, hit upon the idea that a single conductor, fixed rigidly at one end and fastened to the centre of a telephone receiver diaphragm at the other, might be made to perform the functions of a telephone receiver magnet. The sketch (Fig. 1) shows roughly a section of the device used in the experiments. B is the hard rubber shell of an ordinary telephone receiver, and C is its cap. A is a wire fixed conductively at O^1 to the receiver diaphragm D. At O the wire A is so attached to the bind post G that, by turning the bind post, the tension on the wire H and consequently on the diaphragm D may be controlled. Current is lead to wire A by conductor S, and is carried away through S^1, which makes electrical connection with the diaphragm D.

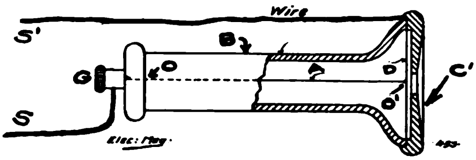


FIG. 1.

If telephone voice currents be caused to flow through A the diaphragm will vibrate in accordance and reproduce speech. It was at first thought that this was an $I^2 R$ heating effect, the sound reproduction being due to the expansion and contraction of the wire A, caused by the varying currents flowing through it, but later it was found that the speech reproduction was apparently as good if the end O of the wire A was left entirely unanchored and the tension removed from the diaphragm D. The introduction of a condenser in the circuit did not appreciably affect the reproducing qualities of the device. When the wire A was increased to twice its original length the difference in transmission was not sensible. When a coiled wire of German silver was substituted for A no great difference could be noted.

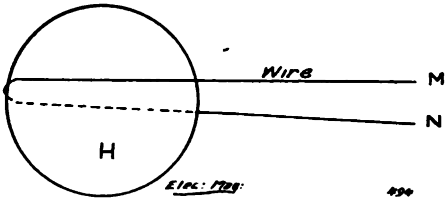


FIG. 2.

Following up this line of investigation the experimenters substituted for the wire A a piece of wire carried once around a diaphragm as shown in Fig. 2. Current enters at M and flows out at N. H is the iron diaphragm. With this arrangement all of the results, using the wire attached to the diaphragm, were secured. Apparently there was no difference in the volume of the reproduced speech, whether there were more than one convolution around the diaphragm, or whether the conductor M N was but once across the diaphragm's face. When another diaphragm was placed over the top of the original the loudness was increased.

The experimenters are inclined to believe that the effects are of a molecular nature. The experiments were limited to copper and German silver wire, and to iron diaphragms. Obviously a receiver designed on this principle would be devoid of self-induction and capacity. The investigators ask "What bearing would this receiver have had upon the telephone patents in 1876?" The patent rights referred to are some of the famous ones by which the Bell Company so long controlled the telephone business in the United States. A report of the investigation is given in *The American Telephone Journal* of April 9th, 1904.

RECENT AMERICAN TELEPHONE PATENTS.

Figs. 1 and 2 show two of the most interesting telephone patents granted in the United States just recently. Fig. 1 (No. 759,316), by W. E. Runge, relates to an improvement in telephone receivers. A method is provided whereby it is possible to secure an adjustment and a means of rigidly locking it, from the rear of the receiver. The gist of the invention lies in the use of the locking ring G, G^1. The magnet A, with the attached parts as shown, is first screwed into the portion F^1, so that the pole pieces C are the proper distance from the diaphragm D. Then the ring G, G^1 is screwed into F^1 against E^1, locking it. The shell B may then be screwed on the part G^1. It should be noticed that all adjustments are made from the rear of the receiver.

Fig. 2 is an extension set circuit (No. 758,703), by C. E. Scribner and James L. McQuarrie, assigned to the Western Electric Company, the manufacturing branch of the Bell Telephone Co. The object of the invention is to provide a circuit whereby the exchange can call either station, both of the stations can call the exchange, and either of the stations may call the other. The exchange may signal either station by means of a code ring, and the stations can call each other by means of the keys n and p. The key l^3, l^4 is used to cut off station B when A is using the line. The operation of the circuit will be obvious.

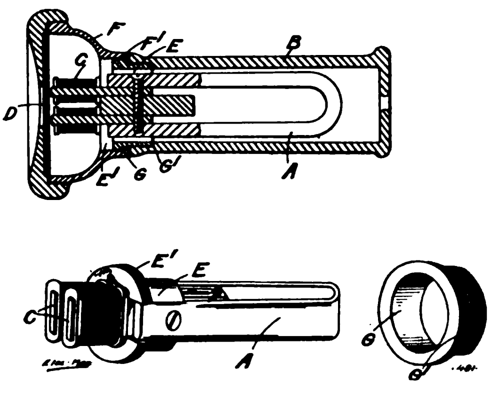


Fig. 1.

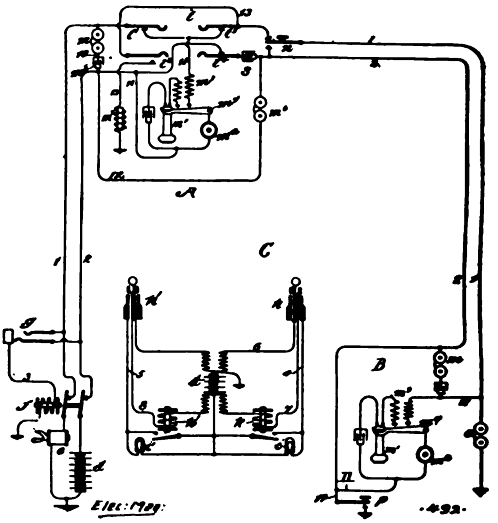


Fig. 2.
(*American Telephone Patents.*)

◆

TELEPHONE NOTES.

Bell Telephone Company borrows 20,000,000 dols.

The American Telephone and Telegraph Company (The Bell) has borrowed $20,000,000, with which, it is reported, it intends to rebuild and extend its systems in the middle west, in which section repairs are badly needed. The amount was borrowed on 5% notes due in three years.

Automatic Exchange at Lincoln, Nebraska.

This western city is rejoicing in the possession of an automatic exchange (Strowger) of an immediate capacity of 3,000 stations; the ultimate is 7,000. The aerial distribution is taken care of by 50 miles of pole line, employing 2,000 Idaho cedar poles from forty to fifty-five feet in height. There are seventy five miles of aerial cable, and 600 miles of B.B. iron wire in the installation. There are 65,000 lineal feet of underground cable used, largely 250 pair.

Railroads Install Telephone System.

Many of the American railroads already have their own telephones, and it has recently been reported that the New York Central and Lake Shore systems, one of the largest eastern roads, is going to install its own service from New York to Chicago. The Illinois Central is perfecting its system, and the Ironton R.R. of Pennsylvania is preparing to install a telephone system and do away with its telegraphs.

Nova Scotia Telephone Figures.

Incorporated in the report of the N.S. Consul at Halifax are some figures of telephonic interest. There is a copper line of 292 miles between Halifax and Sidney, with standard relay boards at both ends. In the province there is one telephone in use for every 88 inhabitants. The Nova Scotia Telephone Co. has 790 miles of pole line, and 2,276 miles of copper wire; the total mileage of telephone wires in the province is 7,136. There are altogether in the province 3,260 telephones, 1801 of which are in Halifax. The average number of calls per telephone per day is 11, and there are made in Halifax daily 18,000 calls. The company last year handled 17,000,000 messages.

Newspaper Utilises the Telephone.

The Ashland (Wisconsin) *Daily Press* makes use of the telephone in a novel fashion to enable it to handle sporting news with dispatch. The typesetting machine operator has a telephone receiver, such as is used by exchange operators, fastened to his ear, and the newspaper's representative at the sporting event, dictates the description to him over a special telephone circuit. The compositor immediately sets the matter into type, thus saving the time that would be consumed in writing the "copy" and getting it to the publication office.

A Telephonic Political Convention.

July 6 is the date set forth for the convention of the Democratic party, at which time it will select its candidate for the coming presidential election. Each state delegation, in the convention hall at St. Louis, Mo., will be in telephonic communication with the delegation from every other state, as well as with the chairman and various clerks. It is expected in this way to avoid the confusion of the past, due to the chair's failure to hear a member's motion, or to recognise speakers at exciting moments. Switchboards will be installed with expert operators to manipulate them.

A Cheap System of Telephone Wires.

In the United States a system of communication is in use in many parts which, while it cannot be called wireless, does away with the necessity of stringing wires and setting poles over a vast extent of territory. The system is to use simply the wire fences wherever possible, making such connections as may be needed here and there by a few extra strands. Many isolated farm houses are enabled in this way to gain connection telephonically with distant towns. We remember to have heard of a similar method being employed in Australia.

TELEGRAPH NOTES.

The Baudot Apparatus.

The Academy of Science (Paris) has bestowed the Hughes prize upon M. Pierre Picard for his improvements in the Baudot apparatus, which have rendered it possible to increase the speed of transmission through submarine cables. The nature of these improvements was explained in our issue of March, page 281. Communication directly between Paris and Algiers has been rendered possible by Picard. The cables connect Marseilles with Algiers; double Baudot distributors are installed at the ends of each cable, and from Marseilles to Paris on the overhead circuit quadruple distributors are in use. Of the three cables, one serves for transmission in two senses between Algiers and Marseilles, which the other two only transmit in one sense. According to the necessities of the traffic, Marseilles can cut in on one of the sectors of the Paris-Algiers circuit. It had been proposed to lay a fourth cable before the introduction of M. Picard's improvements, but this necessity has now been obviated, owing to the increased speed that has resulted, and the public receives the advantage of a printed tape instead of a written message.

The Telegraph in New England.

A writer, Mr. Phillips, discussing the features of telegraph traffic in New York and other large cities connected therewith, refers to the conditions of communication some forty years ago. David Brooks, an eminent telegraphist of that period, complained that the revenue from messages at Harrisburg was insufficient to pay his board. He added that people regarded the telegraph as a toy, and never thought of using it for any serious purpose, employing the mails for their ordinary communications with Philadelphia, and "when they were in a great hurry to receive intelligence," said Mr. Brooks, "they went to Philadelphia in person." They usually walked, but in cases of extreme urgency they took a conveyance. It never occurred to them to use the telegraph.

"But though we had ceased to walk from Harrisburg to Philadelphia, rather than use the wires, telegraph affairs, even as late as 1861, were quite different from what they are now." There are, to-day, in that part of New England lying between New York and Boston, hundreds upon hundreds of wires, the property of the Western Union Telegraph Company, the Postal Telegraph-Cable Company, and the various telephone companies.

Early Telegraph Companies.

Prior to 1859 there had been several telegraph companies organised in New England, including the American Telegraph Company, which, in 1860, absorbed the New York and New England Union Telegraph Company, and for a short time both the Morse and the Phelps Combination Printing Telegraph were used on the lines thus consolidated. The latter was an ingenious combination, made by George M. Phelps, of Troy, N.Y., of the "step by step" printer, invented by Royal E. House, of Vermont, and the harmonic instrument devised by David E. Hughes, a music teacher of Kentucky. Both the House and the Hughes systems, as well as that of an ingenious Scotchman, Prof. Alexander Bain, of Edinburgh, who has but recently died, had previously been exploited separately in this territory by the several competing companies, in opposition to the Morse system, but it seems to have been a case of the survival of the fittest, and one by one they were finally supplanted by the latter, which came to be the telegraph almost exclusively in use all over the United States.

The Enormous Lengths of Circuits a Feature of the Present Day.

With improvements in construction of wires and insulators, the writer in the course of his long career was witness of a remarkable extension of through working: he goes on to say, that of late years, "Our night wire to the Pacific Coast was regularly worked from New York to Winnipeg, who sent as far west as Vancouver, the latter relaying to Seattle, Portland and San Francisco. In handling matter taken from New York morning papers, which was in time for Seattle, Portland and San Francisco, owing to Pacific Coast time being three hours slower than New York time, it was customary to connect through and work direct with those three points. The route to San Francisco, *via* the Canadian Pacific railroad to Vancouver, thence through the forest to Seattle and along the line of the Southern Pacific railroad to San Francisco, is the longest one between the Atlantic and the Pacific, but the wire worked fairly well, and the rate of speed observed in transmitting the early morning report was very seldom slackened. Occasionally, however, we had to relay at Winnipeg or Vancouver, and sometimes at both, for there were forest fires and landslides out in the Rocky Mountains that were very troublesome. But a little thing like a rainfall did not inconvenience us particularly.

WIRELESS TELEGRAPH NOTES.

A Novel Coherer.

A NOVEL coherer, designed by Ca Schniewindt, Neuenrade, Germany, consists of a fine wire gauze of highly conductive metal. The wires of this tissue are cut through, so that all the wires, instead of running continuously from one end to the other, consist of a quantity of short wire fragments. One type of apparatus includes a round piece of wire gauze, separated by a spiral section into a number of windings, the wires of which form by their terminals the edge of the windings. The spiral form, however, is not essential, the cut being as well made in a serpentine or zig-zag line or in a straight line, the bands being connected alternately at one end or the other. On the electric waves impinging on a piece of wire gauze of an infinite resistance, the short wire pieces, being in contact with one another, are rendered conductive in a way analogous to metallic powder coherers. By striking the coherer, the points of contact will be interrupted again, when the coherer resumes its infinite resistance.

Resonance Induction Coils in Wireless Telegraphy.

THE necessity for devices furnishing high amounts of electricity has been felt since the adoption of the Thomson oscillation circuit as an exciter of the sending wire. Dr. G. Seibt (*Elektrotechnische Zeitschr.*), while engaged in experiments in this direction, altered within very wide limits the capacity of the exciting circuit when the efficiency of the induction coil was found to show a maximum as to spark length and spark quality for a given capacity load. Further investigation resulted in some valuable results being found as to the design and operation of induction coils. In the first place it was feasible to establish a loose coupling between the primary and secondary circuits, and to adjust for resonance between the own vibration of the arrangement and the excited vibration. The theory of these improved induction coils or "resonance transformers," is further considered in the paper.

WIRELESS WAVES.

German Campaigning. Germany is said to be sending wireless telegraph equipments to German South West Africa for use in the campaign against the troublesome Herreros.

Exit Marconi. The Lighthouse Board has, we understand, requested the Marconi Co. to remove its apparatus from the Nantucket Lightship, owing to its refusal to receive messages sent by the German system.

Government Northern Station. The Government is said to have acquired a site on the North East Coast for a wireless telegraph station, between South Shields and Sunderland, the location being said to be at Marsden Hall, which has been unoccupied for a number of years. It stands over 200 ft. above sea-level, and is near to the edge of the cliff.

Argentina to Italy. The Marconi Co. has offered to establish a wireless telegraph station in Argentina, to communicate with Italy. *The Review of the River Plate*, commenting upon this, remarks that the fact that a monopoly and a large yearly subvention is asked for should, for either of these reasons alone, secure the rejection of the offer.

Wireless in Panama. A recent convention held at Panama authorised the President to sign a contract authorising the installation of a wireless telegraph system. This has now been successfully inaugurated between Port Limon, Costa Rica and Bocas del Toro, Panama. Another station will be erected at Colon.

In the Navy. In *The Engineer*, the statement recently appeared that the Marconi apparatus had been removed from most of the ships of the Mediterranean Fleet, for economy it was said. The true facts are that the apparatus is only to be left in one out of every four battleships, so that every cruiser may be equipped with the apparatus without increasing the outlay on wireless telegraphy.

From the Eiffel Tower. Experiments in wireless telegraphy are being conducted at the Eiffel Tower by Captain Ferrié, of the French Army, and it is hoped that messages will be sent a distance of several hundred miles. The tower itself is not utilised for transmitting, but merely as a convenient support for an antenna, 350 metres high, rising from a small cabin built on the ground.

Capt. Ferrié's Paper. A *resumé* of Capt. Ferrié's paper on "The latest progress in wireless telegraphy" is appearing in the columns of our contemporary *Electricity*, of New York, from the facile pen of Mons. E. Guarini. As a matter of fact, Capt. Ferrié has published a more recent paper, and one containing more interesting results, but the present series suffers furthermore from the translator's efforts. What can be said of "M. Ferrie stated that the use of wireless telegraphy in public service in France has shown itself to be very prudent. . . . . M. Ferrie has been, until recently, a very great sceptic in respect to wireless telegraphy, which is encouraging for this new kind of communication." Encouraging, indeed!

Peaked Waves. Mr. Daniell M. Moore, of Newark, N.Y., has recently had a patent issued to him, in the United States, for a peaked wave wireless transmission. These waves, by reason of their high rate of change, are considered better suited to produce spheres of wave action over greater distances. Such rapid changes may be produced by interrupting a charged circuit in a vacuum of the highest degree of exhaustion, by bringing the electrodes into contact and then separating them. From the meagre information available (only the claims), no real estimate of the value of the system is as yet possible.

New Coherer. Prof. J. Chunder Bose, whose researches into the response of matter are so well known, has invented a new kind of coherer. This is based upon the property possessed by a number of substances, such as galena, tellurium, lead, tin, etc., of self-recovery from the effects of Hertzian waves. The coherer is made with two contact pieces of such material, one in the form of a cylinder, and the other pointed and bearing on the former, the pressure being regulable by a micrometer screw. It is stated to be very sensitive, but the days of the coherer are practically numbered, there being a universal tendency more and more, to employ current-actuated receivers, instead of potential responsive devices, the resistance of which undergoes such enormous variations.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Day by day striking evidences are presented that Electro-Chemistry has undreamt-of possibilities and lies at the root of most of the power of the future. The products of the electric furnace have already given us some marvellous results. Scientific investigators and captains of industry are becoming increasingly alive to what may be attained through Electro-Chemical research. It is not a remote contingency that by the aid of Electro-Chemistry the maximum percentage of energy available from carbon sources will be utilizable ; that coal may absolutely be removed from the ranks of necessary commodities ; and that the production of iron may be revolutionized. Is it too much of a dream to assume, in fact, that iron may, through the development of Electro-Chemistry, become a bye-product? The gentlemen responsible for this section, who have made the subject a life study, will see to it that the progress of Electro-Chemical work is assiduously followed and recorded herein.

* * *

A New Process for the Protection of Iron and Steel from Corrosion.

By SHERARD COWPER-COLES, M.I.E.E.

Zinc has proved the most effective coating for iron and steel, and hot galvanising, with all its attendant disadvantages, is the process most extensively used for applying the zinc coating. Electro-zincing or cold galvanising, is used for special classes of work, and is largely used by the Admiralty for giving boiler tubes a thin flashing of zinc for the purpose of detecting flaws and protecting the tubes from corrosion during the time of assembly and in action.

Works have just been completed for a new process, to which the name of "Sherardizing" has been given. One point of particular interest about the new process is that iron and steel can be coated with a thin even deposit of zinc at a temperature many hundreds of degrees below the melting point of zinc.

The first step in the process is to free the iron from scale and oxide by any of the well known methods, such as dipping in an acid solution or sandblasting. The articles to be rendered rustless are then placed in a closed iron receptacle, charged with zinc dust, heated to a temperature of from 500% to 600% F. for a few hours and allowed to cool; the drum is then opened and the iron articles removed, when they are found to be coated with a fine homogeneous covering of zinc, the thickness depending on the temperature and the length of time. It will be observed, that the temperature required to bring about this result is about 200% below the melting point of zinc. The low temperature required makes the process cheap as compared to the process of dipping in molten zinc, and has the additional advantage, that it does not deteriorate iron or steel of small section to the same extent as hot galvanising. The whole of the zinc is consumed; there is no waste of zinc as in the hot galvanising process. This new process of dry galvanising is not limited to the coating of iron with zinc, but has been successfully applied to coating iron with copper, aluminium and antimony. It has also been applied to coating various other metals, for instance, aluminium and copper with zinc. Copper and its alloys subjected to this process, are case hardened on the surface and can be rendered so hard as to turn the edge of a steel tool.

The zinc powder used in the process is the zinc dust of commerce, and must not be confused with zinc oxide. It is obtained during the process of distilling zinc from its ores. Zinc dust at the present time is used for a variety of purposes, and can be obtained in any desired quantity. The average price of zinc dust for the year 1903 was £19 19s. 0d. per ton, which is slightly below the average price of virgin spelter. The analysis of two samples of zinc dust, such as are employed for Sherardizing, gave respectively 85% and 85·06%, and 81·86% metallic zinc. Both samples, when examined under the microscope, seemed to

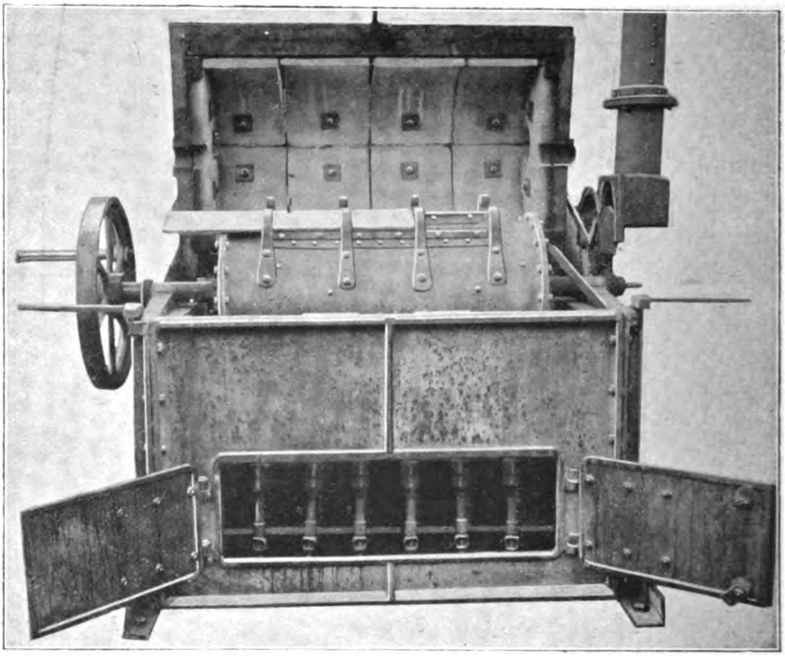


FIG. 1. SHERARDIZING DRUM.

contain small bright metallic beads unevenly distributed through the dust, and it is probable that this may account for the different percentage given by analysis. One of the peculiar properties of zinc dust is that it cannot be smelted or reduced to the metallic form under ordinary conditions, even when heated to a very high temperature under considerable pressure. This property is very advantageous for the new process of dry galvanising (Sherardizing), as it does away with the risk there might otherwise be of melting the finely divided zinc by overheating the furnace. The receptacle in which the zinc dust is placed and heated is preferably air tight, and the air exhausted so as to prevent the formation of too much zinc oxide, or if this is not feasible, it is found advisable to add about 3% of carbon in a very fine state of division. If the percentage of oxide is allowed to increase beyond certain limits, it is found that the deposits become dull in appearance, instead of having a bright metallic lustre, although good deposits of zinc can be obtained from zinc dust varying considerably in composition. To prevent the iron receptacle in which the process of Sherardizing is carried on, from becoming thickly coated with zinc, it is found advantageous to coat the inside of the drum with plumbago or black lead. Articles coated with grease receive as good, if not a better, coating of zinc than those which are free from grease. This fact is of considerable importance, as it enables machine work, such as bolts, nuts, screws, etc., to be thrown direct, after machining, into the Sherardizing drum without any preparation or cleaning. The articles, when they have been heated in the zinc dust for the period necessary to obtain the thickness of zinc required, can be removed whilst the zinc dust is still hot, although the better practice is to allow the zinc dust to cool to a temperature at which the articles can be readily handled, as the

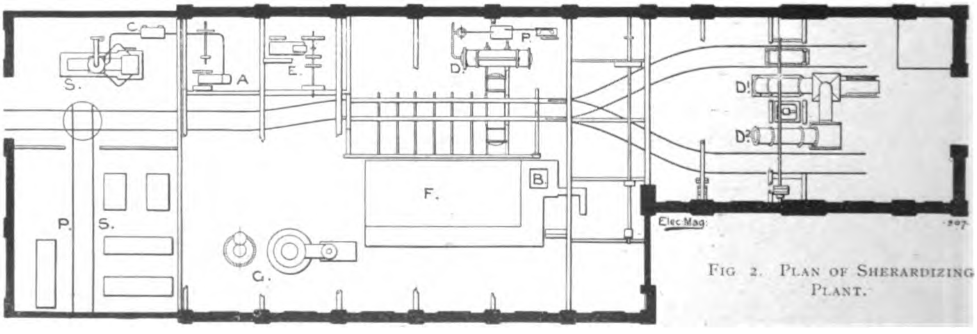


FIG 2. PLAN OF SHERARDIZING PLANT.

A *Air compressor.* B *Chimney stack.* C *Air tank.* D *Sherardizing drum.* D1 *Ditto (filling position).* D2 *Ditto (emptying position).* E *Gas engine.* F *Furnaces.* G *Producer plant.* P *Exhaust pump.* P S *Pickling shed* S *Sandblast*

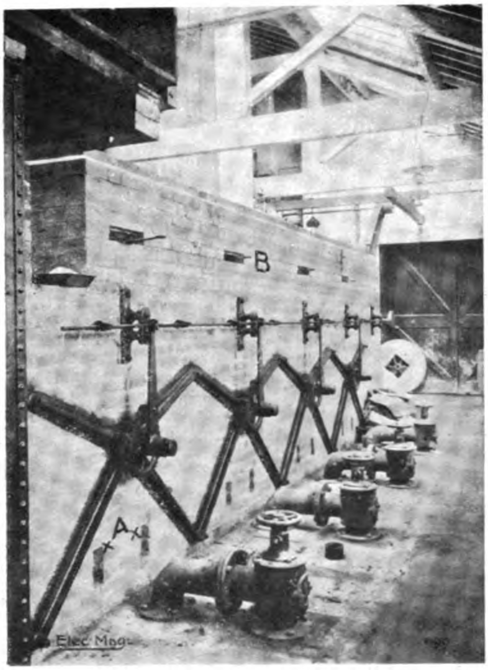


FIG. 3. CONTROLLING VALVES TO FURNACES.

deposit of zinc is whiter and less oxide of zinc is formed. This new process of dry galvanizing offers many facilities and great economy to those manufacturers who have not sufficient work to keep a large bath of molten zinc continuously employed. Articles can be Sherardized at a few hours' notice, starting all cold, as the drums can readily be heated by gas or coke furnaces, the whole operation occupying only a few hours.

A useful type of furnace for small work consists of a closed iron chamber in the form of a cylinder or polygon, and arranged to be rotated or oscillated about an axis. The chamber is provided with an iron door, either at one end or at the side, depending upon the class of articles to be treated. A side door is found to be the most suitable for small articles, such as bolts, nuts, small castings, etc., and the end doors for tubes, oblong or cylindrical articles. In the latter case, the cylinder is oscillated on its axis; in the former case it is rotated and provided with baffle plates, to ensure the articles under treatment being turned over and thus becoming uniformly coated by bringing all parts into intimate contact with the zinc dust. Fig. 1 shows such a furnace suitable for Sherardizing one or two cwt. of small articles at a time; one of the trunnions is made hollow so that a pyrometer can be inserted. Below the furnace is arranged a number of Bunsen gas burners for heating the drum, and the whole is enclosed in a cast-iron shell lined with fire brick. The drum can be rotated either by hand intermittently or continuously by means of a suitable gearing. The plant required for Sherardizing all classes of work must of necessity be modified to suit the different classes of work; for instance, if it is required to Sherardize an expanding gate or girder, an iron box would be used which would be kept stationary during the process of Sherardizing, the gate being opened to its full extent during the operation. Tubes require a different construction of drum to the drum required for bolts and nuts, wire and sheets also require modified arrangements to enable the work to be handled expeditiously. Fig. 2 shows the general arrangement of a Sherardizing plant which has recently been completed, comprising four furnaces, capable of taking drums of 8 in. × 2 in. with a cubic capacity of two tons of material at a charge; the weight of iron capable of being Sherardized per charge depending on how close the articles pack. The furnaces are heated by Dowson gas, which is led by iron pipes to the back of the furnaces, the supply of gas being controlled by iron cocks, as shown in Fig. 3. The gas is then conducted through brick channels, through which the air is drawn through the inlets A, the gas being burnt through cast iron burners A, as shown in Fig. 4.

The charging of the drum is effected by running the truck on which the drum is placed

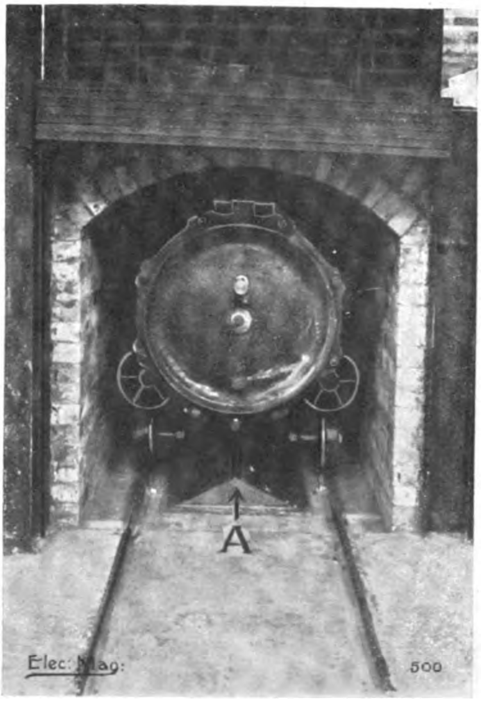


FIG. 4. GAS BURNER AND DRUM

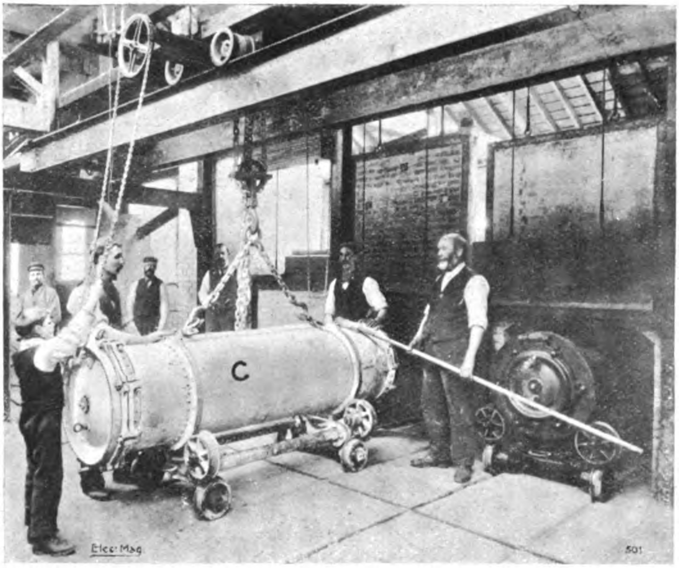


Fig. 5 Placing Drum on Table for Charging

on to a table (Fig. 5). One end is then lowered by means of gearing, so as to tilt the other end, into which the zinc dust is charged from an upper floor, by means of a shoot, F, as shown in Fig. 6. G is a drum being discharged over an iron grating, which allows the zinc dust to fall into a chamber below, from which it is raised by means of a chain elevator to the floor above. When the drum is charged with zinc dust and the articles to be Sherardized, it is brought into a horizontal position, the air exhausted, and the truck run along the lines until it arrives in front of the furnaces. It is then lifted on to a furnace truck, to effect a saving in the first cost of the plant and to save waste of heat. The drum is then pushed into the furnace, the door lowered and the furnace heated up to the desired temperature. When the drum has been in the furnace a sufficient time to give the desired result, the door is then raised and the drum and carriage withdrawn, the drum lifted on to another carriage and run out into an open yard, where it is allowed to cool down to a temperature low enough to admit of easy handling.

The surfaces obtained by hot and cold galvanising, and Sherardizing is different in each case, but they can readily be distinguished by those conversant with the three processes. In the case of hot galvanising the surface is spangled, or if not spangled, has the appearance of cast metal. In the case of cold galvanising, the surface is free from spangles and has a matt or frosted surface, uniform if the work has been well executed. Sherardizing is again distinctive from the two former processes, the general appearance resembles more that of cold galvanising than hot galvanising, but is more lustrous and metallic, and is uniformly distributed over the whole surface, which is not the case with the hot and cold galvanising processes. The Sherardizing process, although similar to cold galvanising in some respects, is also similar to hot galvanising in other respects, inasmuch as the zinc alloys with the iron and forms a protective zinc - iron alloy, intermediate between the zinc coating and the underlying metal. Fig. 7 shows a photomicrograph of hot galvanising, the line in the centre shows the line of demarcation between the crystal or spangles. Fig. 8 shows zinc electro-deposited by the regenerative process from a solution of zinc sulphate, kept in the best working condition by passing the electrolyte through a filter bed of zinc dust and coke, the current density being about 20 amperes per square foot of cathode surface. Fig. 9 shows an iron surface coated with zinc by the Sherardizing process.

In practice, Sherardized iron and steel is found to withstand the ordinary corrosive

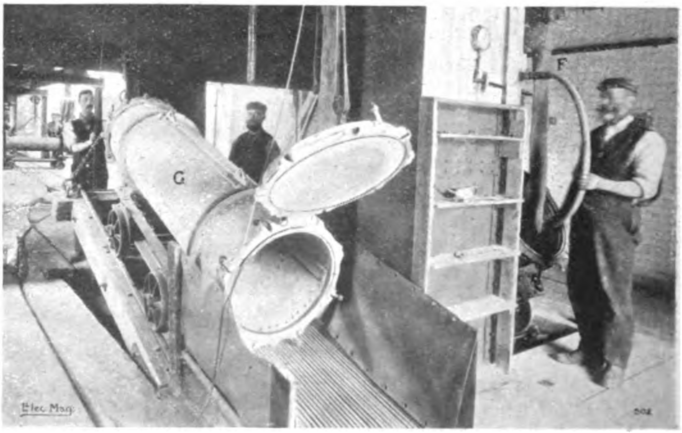
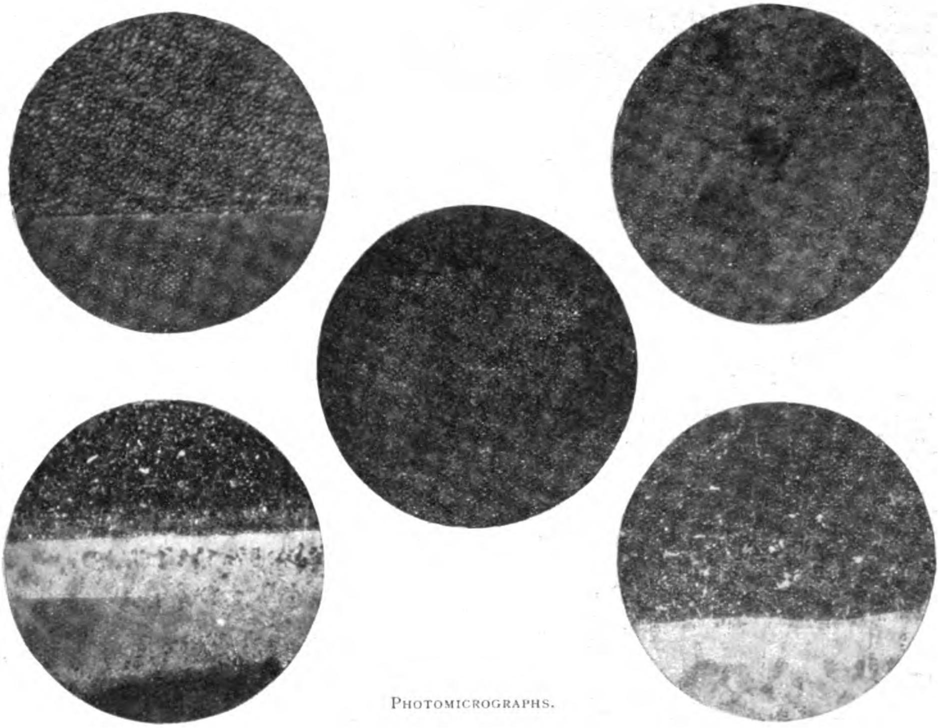


Fig. 6. Drum in Position for Charging.



PHOTOMICROGRAPHS.

FIGS. 7-9. FIG. 10 FIGS 8-11.

agents galvanised iron is exposed to, to a remarkable degree; even after the apparent removal of all the zinc by filing or abrasion, the iron is still non-corrosive. This valuable property is doubtless due to the protective action of the zinc-iron alloy formed on the boundary line between the iron and zinc, and which is clearly shown on the photomicrographs Nos. 10 and 11.

As Sherardizing is effected at a very much lower temperature than hot galvanising, the temper of steel wire is not reduced as it is in the latter process. A number of steel and iron bolts, Sherardized at varying temperatures, when tested for tensile strength, were found to be equal in strength to bolts which had not been Sherardized.

The process is advantageous as compared to hot galvanising for the following reasons:—

(a) There is no waste of zinc due to the formation of zinc iron alloys, as less zinc is required to give the same protective coating, because the zinc is evenly distributed.

(b) The temperature required is lower, consequently the amount of fuel consumed is less.

(c) The labour is less, as the articles do not require to be cleansed as carefully as in hot galvanising.

(d) The cost of working is less than hot galvanising, the plant is very much cheaper, there is no waste of zinc, no flux required, no dross or skimmings formed, no danger of explosion or breaking of castings and distorting of thin iron work. Sherardized machine work does not require refitting, as the coating is evenly distributed. There is no reduction in tensile strength as in the case of hot galvanising, the coating is more uniform and even than that obtained in hot or cold galvanising, the work can be placed direct in the Sherardizing drum from the pickling vat without drying, the process can be worked intermittently without waste, iron can be coated with zinc to any desired thickness. Another advantage of Sherardizing, provided sufficient time is given for coating, is that it has the effect of bringing the surface into a more uniform state of tension.

ELECTRO-PHYSICAL NOTES.

Radium Emanation.

J. A. McCLELLAND, in *The Philosophical Magazine* for April, describes a series of experiments made to determine the question whether the emanation is charged or not.

The results obtained appear to show conclusively that the emanation is uncharged, and it is pointed out that this conclusion has an important bearing on our conception of the manner in which the radium atom breaks up. This atom is known to give off positively charged particles—the Röntgen rays. The emanation particles cannot represent simply the remainder left after the emission of the Röntgen rays, for in that case they would be negatively charged. It follows, therefore, that the atom must have parted with an equal negative charge, either by the emission of negative particles, or in some other way.

Alternate Current Bridge Measurement.

MR. G. A. CAMPBELL, in a recent issue of *The Electrical World and Engineer*, outlines an interesting method which he has devised, by the use of magnetic capacity, and leakage shields, of eliminating the difficulties arising from capacity changes, in applying the Wheatstone Bridge to measurements with alternate currents. The principle of the arrangement may be summarised as follows:—

1. The balance arms are shielded individually and collectively, in order to make the balance definite and invariable.
2. Shielded transformers are introduced into the generator and telephone branches in order to make the arrangement practicable.
3. The bridge corners are suitably shielded, or their admittances to the outside shield suitably proportioned, in order to simplify the numerical computations.

Contribution to the Theory of Differential Arc Lamps.

IN a paper published in *Physikalische Zeitschrift*, recently, W. Biegon von Czudnochowski sets forth a theory of differential arc lamps, comprising a cylindrical iron core and two identical coils, symmetrical to the latter, one of the coils being the only movable part of the system. It is found that for a given construction, the highest sensitiveness with respect to regulation is obtained if the regulating position is such as to give values as high as possible to the attractive forces of the two coils. To obtain this, the distance of the regulating coils should be so chosen as to have the maxima of the attraction curve coincide. In the case of the same lamp being used with other electrodes, giving an arc either longer or shorter, with greater or smaller values of $\frac{dE}{dL}$ than those originally determined, the increase or diminution of the stroke necessary to compensate for sudden current impulsions in inserting, as well as on account of any lack of homogenity of the electrodes, should not be affected by displacing the coils with respect to one another. By placing the core asymmetrically in the regulating position, and by aiding mechanically the coil from which the centre of the core has been removed, it is possible to obtain a special sensitiveness of the lamp, either for current or for tension oscillations with the same normal values of the current and the tension.

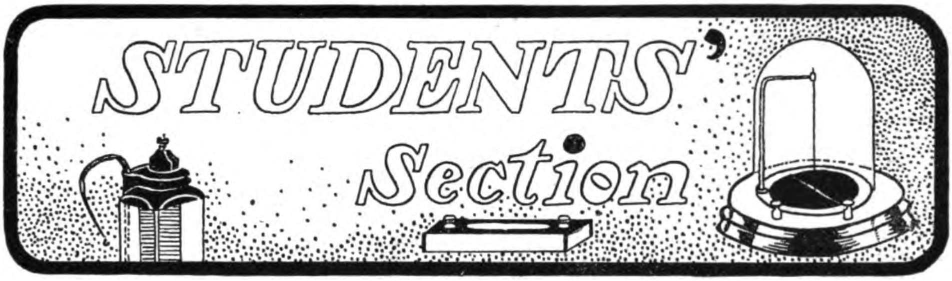
On the Role of Metallic Cores in Coils.

IN a memoir recently read before the French Academy of Science, B. Eginitis examines the influence of metal cores in self-inductive coils with respect to the variable heating effects undergone by the poles according to the variable self-induction of the discharge circuit. The author investigates the influence of iron, brass, and copper, which is found to vary along with the self-induction of the coil, the nature and diameter of the cores, the nature of the poles, the explosive distance, etc., the results being as follows: (1) The influence of a core depends on the shape of the coil. Two coils with the same self-induction, one of which is wound in length and the other in thickness, will give different results, the effect being, of course, the higher in the case of a long coil. (2) Two cores of the same dimensions, one of which is hollow, do not exert the same effects on the discharge. (3) The action of a core decreases as the self induction is increased, augmenting for increasing values of its diameter, at least up to a certain limit. (4) In some cases cores are found to exert no influence at all. A brass core 20 mm. in diameter, and a copper core of 40 mm., on being introduced into a coil of 0,0006 Henry, proved quite inefficient. (5) The action of a core will depend on the temperature of the poles, their nature, and the explosive distance. The compensation of the effect of a core by an artificial increase in the initial temperatures of the terminals is quoted as an instance. (6) Iron cores are found to exert a stronger action than brass cores, the action of which in turn is stronger than that of copper core.

Electric Arcs between Mercury and Carbon.

IN No. 10 of the *Physikalische Zeitschrift*, Dr. L. Cassuto describes some experiments on electric arcs in mercury and carbon. From measurements of the electric tension and current intensity made with both directions of the current and at different distances of the electrodes, it is inferred that for equal current intensities and equal electrode distances, the electrode tension of the arc will be higher if the mercury be the cathode, and the carbon the anode, than in the opposite case. The sum of the anode and cathode tension falls is practically identical for both directions of the current, whereas the tension fall in the arc column is higher in the case of the mercury being cathode than *vice-versa*. These phenomena are accounted for as follows: The column of the electric arc between mercury and carbon will show nearly throughout its length—and no matter which is the direction of the current—the bluish light characteristic of mercury vapor, mercury being vaporised much more strongly than solid carbon. Now the vaporisation of a mercury anode is greater than that of a mercury cathode, the potential fall being higher in the former case. A mercury anode will, therefore, supply the electric arc column with more vapor than a mercury cathode. The potential fall in the arc column, however, depends on the amount of vapor derived from the electrodes, increasing as the latter decreases. The potential fall in the electric arc column must, therefore, be smaller in the case of a mercury anode than in the one of a mercury cathode with less vaporisation.

If you are not a subscriber to "The Electrical Magazine," see that you become one for the next volume. Many new and valuable features will be introduced, making each issue more informative than its predecessors.



STUDENTS' Section

Two of our most eminent professors have undertaken to be responsible for this section, which will be conducted on lines not yet dealt with by any other journal. Whilst not despising the usual "Query and Answer" type of matter (i.e., from one student to another), the Editor of *The Electrical Magazine* feels that something more is wanted, and the Associate Editors will, in this section, lead the thought of the rising generation of electricians, and will, apart from their own independent articles, give advice and opinions in these columns as may be required to all student readers of the Magazine. Other eminent gentlemen will also assist in this section, which it is intended to make a valuable aid to technical training.

Some Illustrations of Approximate Methods of Solving Problems.—I.

By ALFRED HAY, D.Sc., M.I.E.E.

In the practical applications of the electric current, there are comparatively few problems whose solution may be obtained without having recourse to various approximations. Fortunately for the electrical engineer, the results yielded by such approximate methods are frequently sufficiently accurate for all practical purposes. The pure mathematician, in whom a severe training in the most rigid of the abstract sciences, and a constant striving after generalisation naturally create a distaste for anything in the nature of a mere approximation, pronounces many problems insoluble which, to one with a more practical turn of mind, may nevertheless be made to yield more or less accurate solutions. Graphical methods of solution are particularly useful in such cases, and are frequently employed. Of special value in many problems is the use of what is known as "graphical integration," and by means of this Dr. W. E. Sumpner showed, years ago, how to deal with a number of problems formerly considered insoluble.

We propose to exemplify in what follows, the principle of this method, by working out some interesting problems not usually dealt with in text-books. As a first example, we shall consider the case of a ring, of the dimensions shown on the accompanying sketch, uniformly wound over with 215 turns of No. 14 S.W.G., arranged in a single layer, and having a resistance of ·34 ohm. The ring core is supposed to consist of sheet steel stampings, for which the B-H curve is known, and 10% of the length measured parallel to the axis of the ring is supposed to be occupied by the insulating varnish between the discs. The core is supposed to have been completely de-magnetised, and a steady P.D. of 3·4 volts is suddenly applied to the ends of the coil. The problem is to find the law according to which the current establishes itself in the coil—*i.e.*, to draw a curve whose abscissæ represent time (the origin corresponding to the instant of closing the circuit), and whose ordinates give the corresponding values of the current.

During the period of current growth, *i.e.*, before the current reaches a practically steady

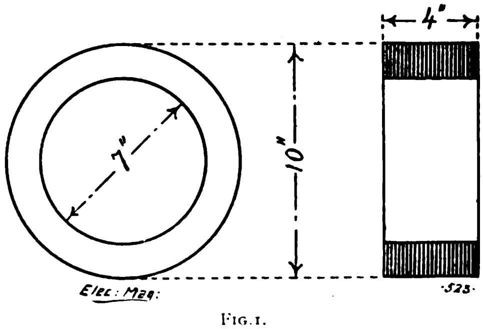


Fig. 1.

value, there will be a varying magnetic flux through the ring, and, in consequence of this, an induced E.M.F. in the coil which *opposes* the current. The P.D. of 3·4 volts impressed on the coil is thus employed in two ways: (1) in maintaining the current through the resistance of the coil; and (2) in balancing the opposing induced E.M.F. Now since the induced E.M.F., in volts, is at any instant given by 10^{-8} times the rate of change of the total flux, in C.G.S. units, linked with the coil, we have, if i stand for the current in amperes,

$$3{\cdot}4 = {\cdot}34\, i + \text{rate of change of flux over cross-section of ring} \times 215 \times 10^{-8},$$

the factor 215 (number of turns in coil) being introduced because the flux distributed over the cross-section of the ring is linked with *each* turn of the coil, so that the total linkage of flux is 215 times the flux over the ring cross-section. Now the nett cross-section of *iron* in the ring is $\cdot9 \times 4 \times 1{\cdot}5 = 5{\cdot}4$ sq. inches, or $5{\cdot}4 \times 6{\cdot}45 = 34{\cdot}8$ sq. cms. Hence if B = magnetic induction at any instant, the total flux over the cross-section of the ring at the same instant is given by $B \times 34{\cdot}8$, and our equation becomes

$$3{\cdot}4 = {\cdot}34\, i + \text{rate of change of } B \times 34{\cdot}8 \times 215 \times 10^{-8},$$

whence

$$\text{rate of change of } B = \frac{{\cdot}34\,(10 - i)}{34{\cdot}8 \times 215 \times 10^{-8}} = 4540\,(10 - i) \; \ldots\ldots \; (1)$$

By means of this equation, we are able to calculate the rate of change of the induction corresponding to any given value of the current. In order to enable us to solve the problem, we must, in addition to the relation connecting current with rate of change of induction, also know the relation connecting current with induction. Now the B-H curve is supposed to be known,* hence in order to find the relation connecting B and i, we must determine that connecting H and i. The mean length of our magnetic circuit being $\pi \times 8{\cdot}5 = 26{\cdot}7$ inches, or $26{\cdot}7 \times 2{\cdot}54 = 67{\cdot}8$ cms., the M.M.F. (magnetomotive-force) around it is $67{\cdot}8\ H$. But the M.M.F. is also equal to $\frac{4\pi}{10}$ or 1·257 times the ampere-turns. Hence

$$67{\cdot}8\ H = 1{\cdot}257 \times 215 i,$$

so that

$$i = \frac{67{\cdot}8}{1{\cdot}257 \times 215} H = {\cdot}251\ H \; \ldots\ldots \; (2).$$

When the current has reached the steady value of 10 amperes, H has a value of $\frac{10}{\cdot251} = 39{\cdot}8$, and on referring to our B—H curve, we find that this corresponds to $B = 16{,}750$. Now although the rate at which B increases varies from instant to instant, yet if we confine our attention to a very brief interval of time, corresponding to a very small change in B, we may without appreciable error assume that during such a brief interval the rate at which B changes is sensibly constant, and equal to its mean rate of change during the interval. Let us, then, suppose that B increases in 25 equal instalments, each instalment therefore corresponding to an increase of $\frac{16{,}750}{25} = 670$, and that during each of these instalments, the rate at which B increases is approximately constant. Now, the mean value of B during the first instalment or time-interval, while B increases from zero to 670, is $\frac{670}{2} = 335$. During the second instalment, the mean value of B is $670 + \frac{670}{2} = 1005$; during the third instalment, it is $1340 + \frac{670}{2} = 1675$; and so on. We may now construct the following table, containing 25 rows (corresponding to the 25 instalments or time-intervals) and 4 columns, obtained as follows. Column I contains the mean values of B (found as just explained) during each time-interval; column II contains the corresponding values of H, got from the B—H or magnetisation curve; column III contains the corresponding values of i, calculated by means of equation (2); and lastly, column IV. contains the corresponding mean rates of change of B during each interval, calculated by means of equation (1).

By means of this table, we find that since the

I.	II.	III.	IV.
B	H	$i = {\cdot}251\ H$	Rate of change of $B = 4540\,(10 - i)$.
335	1·02	·256	44,240
1,005	1·86	·467	43,280
1,675	2·00	·502	43,130
2,345	2·20	·552	42,900
3,015	2·40	·602	42,680
3,685	2·60	·653	42,450
4,355	2·80	·703	42,220
5,025	3·15	·791	41,800
5,695	3·41	·856	41,520
6,365	3·78	·949	41.090
7,035	4·16	1·044	40.650
7,705	4·60	1·155	40,150
8,375	5·12	1·285	39.560
9,045	5·70	1·43	38,900
9,715	6·40	1·606	38.100
10,385	7·20	1·81	37.180
11,055	8·10	2·03	36,180
11,725	9·20	2·31	34.900
12,395	10·4	2·61	33,550
13,065	11·9	2·99	31,820
13,735	13·9	3·49	29.560
14,405	16·8	4·22	26,240
15,075	20·3	5·10	22,250
15,745	25·0	6·27	16,930
16,415	32·8	8·23	8,040

---

* This curve is not drawn, but from the values of B and H given in the tables herewith, the reader can easily plot it for himself.

mean rate of change of B during the first interval is 44,240, a change of one line will take place in $\frac{1}{44{,}240}$ sec., and hence the change from zero to 670 will take place in $\frac{670}{44{,}340}$ = ·01514 sec. Again, during the second interval the mean rate of change of B is 43,280, hence the change of B from 670 to 1340 will take place in $\frac{670}{43{,}280}$ = ·01548 sec. Similarly we find for the duration of the third interval $\frac{670}{43{,}130}$ = ·0155 sec. Proceeding in this way, we determine the duration of the consecutive intervals, as given in the following table:—

No. of Interval	1	2	3	4
Duration of Interval	·01514	·01548	·01550	·01562
No. of Interval	5	6	7	8
Duration of Interval	·01570	·01580	·01588	·01600
No. of Interval	9	10	11	12
Duration of Interval	·01620	·01631	·01648	·01668
No. of Interval	13	14	15	16
Duration of Interval	·01694	·01722	·01758	·01800
No. of Interval	17	18	19	20
Duration of Interval	·01850	·01920	·01996	·02104
No. of Interval	21	22	23	24
Duration of Interval	·02267	·02553	·03012	·03955
No. of Interval	25			
Duration of Interval	·08336			

Now we know the value of B at the end of each interval; hence, by once more referring to the B—H curve, we can find the value of H, and from this calculate the value of *i*, at the end of each interval. This will finally enable us to plot the curve connecting values of *i* and *t*, and so obtain the solution of our problem. The values so calculated are given in the following table. The values of the time *t*, it may be explained, are obtained at once by adding the durations of the successive time-intervals up to the instant under consideration. Thus, the value of *t* at the end of the first interval is ·01514 sec.; its value at the end of the second interval is ·01514 + ·01548 = ·03062 sec.; at the end of the third interval it is ·03062 + ·01550 = ·04612 sec; and so on.

t	B	H	*i*
·01514	670	1·48	·372
·03062	1,340	1·87	·467
·04612	2,010	2·11	·530
·06174	2,680	2·32	·582
·07744	3,350	2·55	·640
·09324	4,020	2·74	·688
·10912	4,690	3·00	·753
·12512	5,360	3·26	·818
·14132	6,030	3·60	·904
·15763	6,700	3·92	·984
·17411	7,370	4·28	1·074
·19079	8,040	4·85	1·217
·20773	8,710	5·40	1·355
·22495	9,380	6·02	1·511
·24253	10,050	6·80	1·707
·26053	10,720	7·65	1·920
·27903	11,390	8·60	2·159
·29873	12,060	9·85	2·472
·31819	12,730	11·00	2·761
·33923	13,400	12·90	3·238
·36190	14,070	15·30	3·840
·38743	14,740	18·50	4·644
·41755	15,410	22·50	5·648
·45710	16,080	28·40	7·128
·54046	16,750	39·80	10

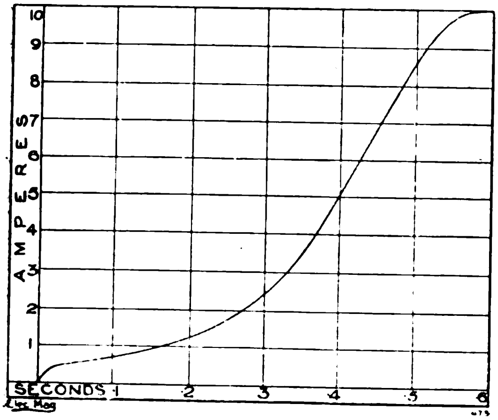


FIG. 2.

The curve connecting current with time is shown in the accompanying figure, and it presents certain interesting peculiarities which, however, might have been anticipated from what we know regarding the B—H curve. At the instant when the circuit is first closed, the permeability is low, a given change of current produces only a comparatively small change of flux, hence a rapid rise is possible. Soon, however, we reach the upward bend in the B—H curve, the permeability increases very rapidly, a given change of current produces a very large change of flux, and the current is consequently able to rise only with extreme slowness. This goes on until the second bend or knee of the B—H curve is reached. At this point the permeability begins to decrease rapidly, and as a consequence the rate at which the current increases becomes greater. The first two bends in the time-current curve thus correspond to the two bends in the B—H curve.

A few words of explanation are necessary regarding the last portion of the curve. According to our approximate method, the current reaches its steady value of 10 amperes in ·54 of a second. In reality, however, it is not quite equal to this value at the instant considered. If we wish to trace the upper portion of the curve more accurately (which, as a matter of fact, has been done in the accompanying figure), it becomes necessary to take a number of additional smaller intervals between B = 15,745 and B = 16,415 in the first table. The more intervals we take the greater will be the accuracy of the result, and it will be found that the time corresponding to $i = 10$ increases with the number of additional intervals. If the number of intervals were made infinitely great, an infinite time would be required to allow the current to reach its steady value: the curve shown in the figure becomes more and more nearly parallel to the axis of time, never, however, actually reaching parallelism. It must not, however, for this reason be assumed that the approximate method employed is incapable of giving accurate results; on the contrary, even ·54 sec. after closing the circuit, the current differs from its steady value by only a small fraction of it, and the accuracy of the solution may be indefinitely increased by sufficiently increasing the number of intervals.

In our problem, we assumed the B—H curve to be given, and from it we deduced the *i*—*t* curve when a steady impressed E.M.F. was applied to the circuit. It is evident, however, that by retracing our steps we could solve the converse problem of determining the B—H curve when the *i*—*t* curve is given. It is interesting to note that this very method of finding the B—H curve was actually used, some twelve years ago, by Prof. Thomas Gray, of the United States, who, by suitable experimental arrangements, traced the *i*—*t* curve, and from it deduced the B—H curve.

Problems in Dynamo-Design.—IV.

By E. H. CRAPPER, M.I.E.E.

CALCULATION OF E.M.F.s.

(1) *A rectangular frame is wound with* 100 *turns of wire, the average area enclosed by the turns of wire is* 500 *sq. cms., and the frame is revolved at* 1,000 *revolutions per minute about an axis bisecting the frame, and lying in the plane of the coils in an uniform magnetic field of* 750 *C.G S. units, the axis of rotation being at right angles to the direction of the field. What will be the value of the alternating E.M.F. generated?*

(2) *If in the above all the conditions remain the same, but instead of the* 100 *turns of wire being in one or parallel planes they are distributed around the surface of a cylinder of non-magnetic and non-conducting material (to form a drum or barrel winding), and provided with a commutator sector at each turn, and brushes as in a dynamo. what will be the steady E.M.F. generated, neglecting any consequences that might result from some coils being short circuited at the brushes?* (City and Guilds Examination in Electric Lighting and Power Transmission, 1903).

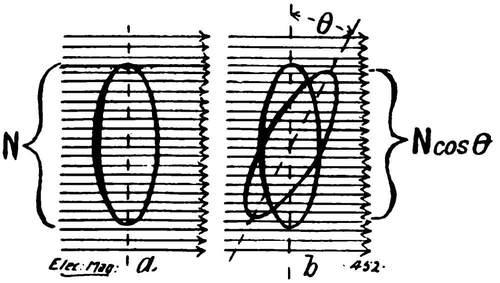


FIG. 1.

These questions, dealing with the determination of the magnitudes of induced pressures and the generation of E.M.F.s by dynamo machinery, are important from the fact that their solution requires the knowledge of the relationship which exists between the E.M.F. induced and the number of conductors, the intensity of the magnetic field, and the rate at which the lines of force are cut by the conductors. According to Faraday's "Laws of Electro-magnetic Induction," the magnitude of the E.M.F. induced in a coil rotating in a magnetic field is *proportional to the time-rate of change of the magnetic flux threading the coil*, and if we consider what takes place when a single coil of wire rotates with uniform angular velocity in a uniform magnetic field, so that relative motion takes place between the coil and field, we shall be able to deduce a working formula. Let, for instance, a coil of a single turn of wire of area *A* sq. cms. be placed with its plane perpendicular to the direction of the field, the intensity of which is **B** lines of force per sq. cm. The flux enclosed by the coil will be $A\,\mathbf{B}$ lines of force, so long as the coil is vertical (see Fig 1. a). If the coil be free to revolve about a horizontal axis, the direction of which is perpendicular to the direction of the field, the rotation through 90° from the vertical to the horizontal position is equivalent to emptying the coil of lines of force, and the variation of the flux embraced by the coil is $A\,\mathbf{B}$. The rotation through the next quadrant or 90° into the vertical position again is equivalent to the projection of $A\,\mathbf{B}$ lines of force through the coil. Also, during the complete revolution through 360° the coil is emptied and filled twice with lines of force, and the rate of variation in the flux embraced by the coil is $4A\,\mathbf{B}$ per revolution. This fact may also be expressed by saying that the rate of cutting of the lines of force by the coil is $4A\,\mathbf{B}$ per revolution. If the coil consists of *C* turns of wire and makes *n* revolutions per second, the average rate of variation of the lines *linked* or *looped* with the coil (*i.e.*, *the number of linkages*) will be

$$\text{average number of linkages per second} = 4A\,\mathbf{B}\,C\,n \quad \text{- - - -} \quad (1)$$

But, by definition, an absolute unit (C.G.S.) of electromotive force is induced, when the time-rate of change in the number of linkages is *one linkage per second*; consequently, the *average induced* E.M.F. is

$$E_{\text{aver}} = 4A\,\mathbf{B}\,C\,n \text{ absolute units}$$
$$= 4A\,\mathbf{B}\,C\,n\;10^{-8} \text{ volts} \quad \text{- - - - -} \quad (2)$$

since there are 100,000,000 or 10^8 absolute units in one volt. Consideration of the laws of induction from the physical point of view, reveals the fact that in each complete revolution of the coil, the induced E.M.F is reversed twice in direction, and is alternating in character. The rate of change in the number of linkages also varies from instant to instant in a periodic manner; that this must be so is obvious if we trace how the number of lines embraced by the coil varies from instant to instant. The maximum number of lines embraced by the coil occurs when it is in the vertical position, and is then $A\,\mathbf{B}$, which may be denoted by N. When the coil has moved through an angle θ, from the vertical position, the number of lines embraced by the coil (for the position shown in Fig. 1. b) will be N cos θ, and the time-rate of change of N cos θ gives the rate of change in the number of linkages from instant to instant. By the calculus this is given as

$$\text{time-rate of changes of linkages} = \frac{d\,(\text{N}\cos\theta)}{d\,t},$$

which indicates that the time-rate of change varies as sin θ

Therefore, if the maximum instantaneous value of the E.M.F. induced be denoted by $E_{\text{max.}}$, and this occurs when $\theta = 90^\circ$, the instantaneous value of the E.M.F. induced at any instant may be expressed as

$$e = E_{\text{max.}} \sin\theta \quad - - - - - - - \quad (3)$$

and the E.M.F. induced in a coil rotating with uniform angular velocity in a uniform magnetic field varies from instant to instant as the sine of an angle proportional to the time. Now the mean or average of a series of values varying as the sine of an angle from 0° to 180° may be shown to be $\frac{2}{\pi}$ times the maximum value, so that in our case

$$E_{\text{aver.}} = \frac{2}{\pi} E_{\text{max.}} \quad - - - - - - - - \quad (4)$$

or, in words, the average of all the instantaneous values of the E.M.F. induced in the rotating coil as it rotates through 180° is $\frac{2}{\pi}$ times the maximum value. But by equation (2)

$$E_{\text{aver.}} = 4\ A\mathbf{B}\ C\ n\ 10^{-8} \text{ volts}$$
$$= 4\ \text{N}\ C\ n\ 10^{8} \text{ volts}$$
$$\therefore\ \frac{2}{\pi} E_{\text{max.}} = 4\ \text{N}\ C\ n\ 10^{-8}$$
$$\text{and } E_{\text{max.}} = 2\ \pi\ \text{N}\ C\ n\ 10.^{8} \text{ volts} \qquad (5)$$

If the two ends of the coil be connected to two slip rings which rotate with the coil, and are insulated from each other, it will be found that an electrostatic voltmeter connected by means of collecting brushes, and pressing on the rings does not indicate the pressure corresponding to the value obtained from equation (5). This is because the attraction and repulsion exerted between the plates of an electrostatic voltmeter are proportional to the square of the difference of potential existing between the terminals of the instrument, consequently the indications of an electrostatic voltmeter are proportional to the square root of the mean of the squares of the forces acting. When the differences of potential applied to the terminals of an electrostatic voltmeter vary from instant to instant as the sine of an angle proportional to the time, the indication of the voltmeter is the measure of the square-root-of-the-mean-of-the-squares-of-the-instantaneous-values, and this may be shown to be $\frac{1}{\sqrt{2}}$ times the maximum value. This is termed the *effective* or *virtual* value of the pressure, and if denoted by $E_{\text{virt.}}$ we have

$$E_{\text{virt.}} = \frac{1}{\sqrt{2}}\ E_{\text{max}} \quad - - - - - - \quad (6)$$

Consequently the reading of the electrostatic voltmeter corresponds to

$$E_{\text{virt.}} = \frac{1}{\sqrt{2}}\ (2\pi\ \text{N}\ C\ n\ 10\ ) \text{ volts,}$$

and by substitution of the value given in equation (5) we have

$$\left.\begin{aligned} E_{\text{virt.}} &= \sqrt{2}\ \pi\ \text{N}\ C\ n\ 10^{-8} \\ &= 4{\cdot}44\ \text{N}\ C\ n\ 10^{-8} \end{aligned}\right\} \quad - - - - \quad (7)$$

This formula gives the relationship between the effective value of the alternating E.M.F. induced in a coil of the type referred to in question 1, in terms of the maximum flux enclosed, the number of turns of wire and the number of revolutions; therefore, by the substitution of the values given, the value of the alternating E.M.F. generated will be

$$E_{\text{virt}} = 4{\cdot}44\ (500 \times 750)\ 100 \times \frac{1000}{60} \times 10^{-8}$$
$$= 27{\cdot}75 \text{ volts.}$$

In the second question the conductors are arranged as an ordinary continuous current armature with a commutator, and the relationship between the steady E.M.F. induced and the given factors may be found as follows:

Each conductor cuts 2N lines per revolution, and the armature makes $\frac{n}{60}$ revolutions per sec.

$\therefore$ E.M.F. induced in each conductor

$$= 2\text{N} \times \frac{n}{60} \times 10^{-8} \text{ volts.}$$

It must be observed here that in a continuous current armature each complete coil supplies two conductors.

Since, however, the brushes divide the armature coils into two equal portions and connect them in parallel, the steady E.M.F. which results will be that induced in each half of the armature; consequently, the number of conductors taken into consideration will be $\frac{1}{2}\,C^1$, where C^1 denotes the actual number of conductors connected in series,

$\therefore$ number of lines of force

$$\text{cut per second} = 2\text{N} \times \frac{C^1}{2} \times \frac{n}{60}$$

and the E.M.F. induced $= \text{N}C^1 \frac{n}{60} \times 10^{-8}$

This is the fundamental formula in continuous current dynamo design, and by the substitution of the values given the steady E.M.F. generated will be found to be

$$E_c = \frac{\text{N}C^1 n}{10^8 \times 60} \text{ volts.}$$
$$= \frac{(500 \times 750) \times 200 \times 1000}{10^8 \times 60}$$
$$= 12{\cdot}5 \text{ volts.}$$

Note.—100 coils form 200 conductors in the drum winding.

Alternating Current Working.

In *The Western Electrician* (Chicago) for April 9th, 1904, Mr. Gump commences a series of articles on the above subject, from which we abstract the following paragraphs:

The phenomena attending the flow of an alternating current are more complex than those of a

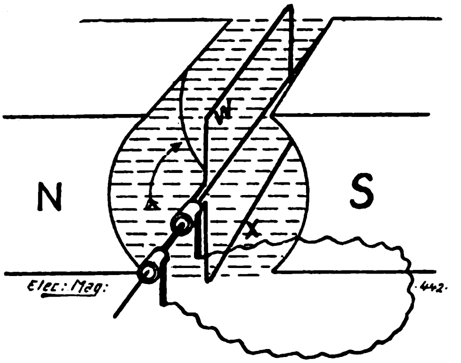


Fig. 1.

continuous current, because (1) an alternating E.M.F. is continually changing its value, first rising from zero to a maximum, then diminishing to zero: reversing, again rising to a maximum in the opposite direction, and again diminishing to zero; (2) the current produced by this E.M.F. is likewise variable; and (3) the current may not be in phase with the impressed E.M.F. producing it. The author shows how a rectangular coil of wire (see Fig. 1), rotating with uniform angular velocity in a uniform magnetic field, gives rise to an E.M.F. which varies as the sine of an angle proportional to the time, and when dealing with the *effective* or *square-root-of-the-mean-square* value of an alternating sinusoidal quantity, gives a trigonometric demonstration of its derivation, which, although not perfectly rigid, may be instructive. If OB in Fig. 2 represents the maximum value of an alternating current, then the successive instantaneous values of the current for a complete period will be given by the projections of OB upon the diameter RT, as OB revolves about the point of origin O. The line AB represents the instantaneous value just at the instant when OB has described the angle θ. Now, by geometry,

$$(AB)^2 + (OA)^2 = (OB)^2$$

$$\therefore \quad \left(\frac{AB}{OB}\right) + \left(\frac{OA}{OB}\right) = 1$$

$$\text{and} \quad \sin^2\theta + \cos^2\theta = 1$$

But during the rotation of OB through a quadrant $\sin^2\theta$ and $\cos^2\theta$ pass respectively through the same series of values, consequently their average values will be equal as θ changes from 0° to 90°, or

$$\text{Aver. } \sin^2\theta = \text{Aver. } \cos^2\theta$$

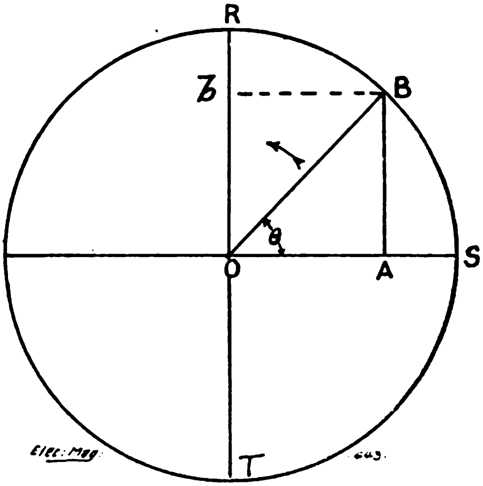


Fig. 2.

$$\text{and} \quad \text{Aver. } \sin^2\theta + \text{Aver. } \cos^2\theta = 1$$

$$\therefore \quad 2 \text{ Aver. } \sin^2\theta = 1$$

$$\text{and} \quad \text{Aver. } \sin^2\theta = \tfrac{1}{2}.$$

Now, the *effective value* of an alternating current—*i.e.*, the value producing the same heating effect as a continuous current—is proportional to the square root of the average of all the instantaneous values squared, and therefore

$$\sin\theta = \sqrt{\tfrac{1}{2}} = \sqrt{\tfrac{1}{2}}$$

$$= \cdot 707 \times \text{maximum value}$$

In other words, the effective or $\sqrt{\text{mean square}}$ value of an alternating sinusoidal E.M.F. or current is 70·7% of the corresponding maximum value. Such is the value given by a voltmeter or ammeter.

After explaining self-induction, and stating that the E.M.F. of self-induction is proportional to the square of the number of turns forming the winding of a coil, Mr. Gump defines the *coefficient of self-induction* as that constant by which the time rate of change of current value in a circuit must be multiplied to give the electromotive force induced. This coefficient is denoted by the symbol L, and in the system of practical units is 10^9 times as large as the absolute unit of inductance, the latter being too small to be employed in commercial calculations.

FROM PROFESSOR to Student.

Would you kindly inform me where and how I can obtain working drawings of electric motors, dynamos, and electrical machinery generally? I am a student in a machine drawing and construction class, but find a difficulty in getting examples of electrical machinery.

There are several standard treatises in existence which contain scale drawings of electrical machinery Among the best known are G. Kapp's "Dynamo Construction" (Biggs & Co.; price about £1), and Parshall & Hobart's "Electric Generators" (published by *Engineering*: price about £1 10s.). Other well-known works, such as S. P. Thompson's "Dynamo-Electric Machinery" (E. & F. N. Spon; price £1 10s.) and Hawkins and Wallis's "The Dynamo" (Whittaker & Co.; price 15s.), also contain a number of scale drawings of dynamos and motors. Probably our correspondent's best plan would be to ask for some of the above at a good reference library. A large number of beautifully executed drawings also appear each month in "Traction and Transmission," a monthly supplement to *Engineering* (each monthly part costs 2s.).

MANUFACTURERS' Section

Under this section will be described everything worth notice in new electrical machinery and appliances. These pages are open to manufacturers, and the Editor will be glad to receive information with regard to new plant or developments, together with photos, plans, and other data, when, if considered worthy of publication, suitable illustrations will be made by the proprietors of *The Electrical Magazine* free of cost. In this connection, however, it is desired to emphasize that the notices will be *original* and of real technical value, compiled by expert men on the staff of this Magazine, who will be commissioned to inspect the machinery under notice. Nothing in the nature of a "puff" will be inserted, and as a thoroughly independent and impartial attitude will be preserved, the utmost reliability can be placed upon the published descriptions. The productions of the manufacturers of electrical specialities of all countries will receive critical attention, and will be profusely illustrated. This in itself cannot fail to be of considerable interest to our readers, and of benefit to manufacturers, whose interests *The Electrical Magazine* will strive by every means to advance.

* * *

Thermal Storage for Steam Boilers.

By W. NOBLE TWELVETREES, M.I.Mech.E., A.M.I.E.E.

THE simple arrangement proposed some years ago by Mr. Druitt Halpin, for economising fuel consumption and increasing evaporation in steam boilers, is now attracting the attention of electrical engineers. Mr. Halpin advocated the storage of the heat contained in surplus steam generated in steam boilers during periods of light load, by passing the steam into a cylindrical vessel filled with cold water, the water thus heated being used for feeding purposes when the load again increased. About ten years ago the first plant installed on this system was tested by Professor Unwin. The thermal storage vessel, measuring 25 ft. long by 4 ft. diameter, was fitted above two Cornish boilers, each 26 ft. 6 in. long by 5 ft. 6 in. diameter, the boilers having an evaporative duty of 10lbs. of water per pound of coal at and from 212 deg. F. During the first week of the test No. 1 boiler only was used, without thermal storage, and during the second week No. 2 boiler was worked with thermal storage. Careful measurements showed that the power consumption was practically identical during the two weeks in question, while the figures in Professor Unwin's report made evident the fact that the coal, consumption had been reduced by more than 19 per cent. This result was sufficiently satisfactory, although not susceptible for explanation by any hitherto accepted theory. In spite of Mr. Halpin's persistent advocacy, the system has not been generally adopted by engineers, but, as we intimated at the commencement of this article, it is now receiving attention from electricians. As an example, we may mention its application at the generating station of the Kensington and Knightsbridge Electric Light Company, where the engineer found it necessary to provide for an additional load of 1,000 kw. without involving extension of the existing buildings. After due consideration it was decided to adopt the thermal storage system as a means of obtaining the augmented evaporation required. The boilers, which are of the Babcock-Wilcox type, and each capable of evaporating 12,000 lbs. of water per hour, were furnished with two thermal storage cylinders, above which were placed water storage tanks. The cylinders are connected with the boilers by means of stand pipes, so that the temperature and pressure are the same as those in the boilers themselves, and the whole of the feed water is passed through the cylinders. During times of light load the cylinders are filled up, and when the load increases, the pumps are stopped, and the boilers fed from the heated water contained in the cylinders. It will be seen, therefore, that there is an intermittent exchange of heat between the boilers and storage cylinders, the periods being dependent, of course, upon alternations of loads. The important point to be noted is that since the application of the system the evaporative duty of the boilers has been doubled. Naturally, the consumption of coal is greater than before, but the quantity is not double that previously consumed. The particularly satisfactory results to which we refer are the more remarkable for the reason that hot feed water was already in use before the adoption of the thermal storage system at Knightsbridge. We are, therefore, brought face to face with the fact that the system offers a method of boiler feeding far superior to any other yet known. This feature alone entitles the thermal storage system to the serious consideration of manufacturers generally, as well as of electrical engineers who are troubled with heavy fluctuations of load.

GRAHAM, MORTON & CO.'S WORKS.

Electric Driving, Etc.

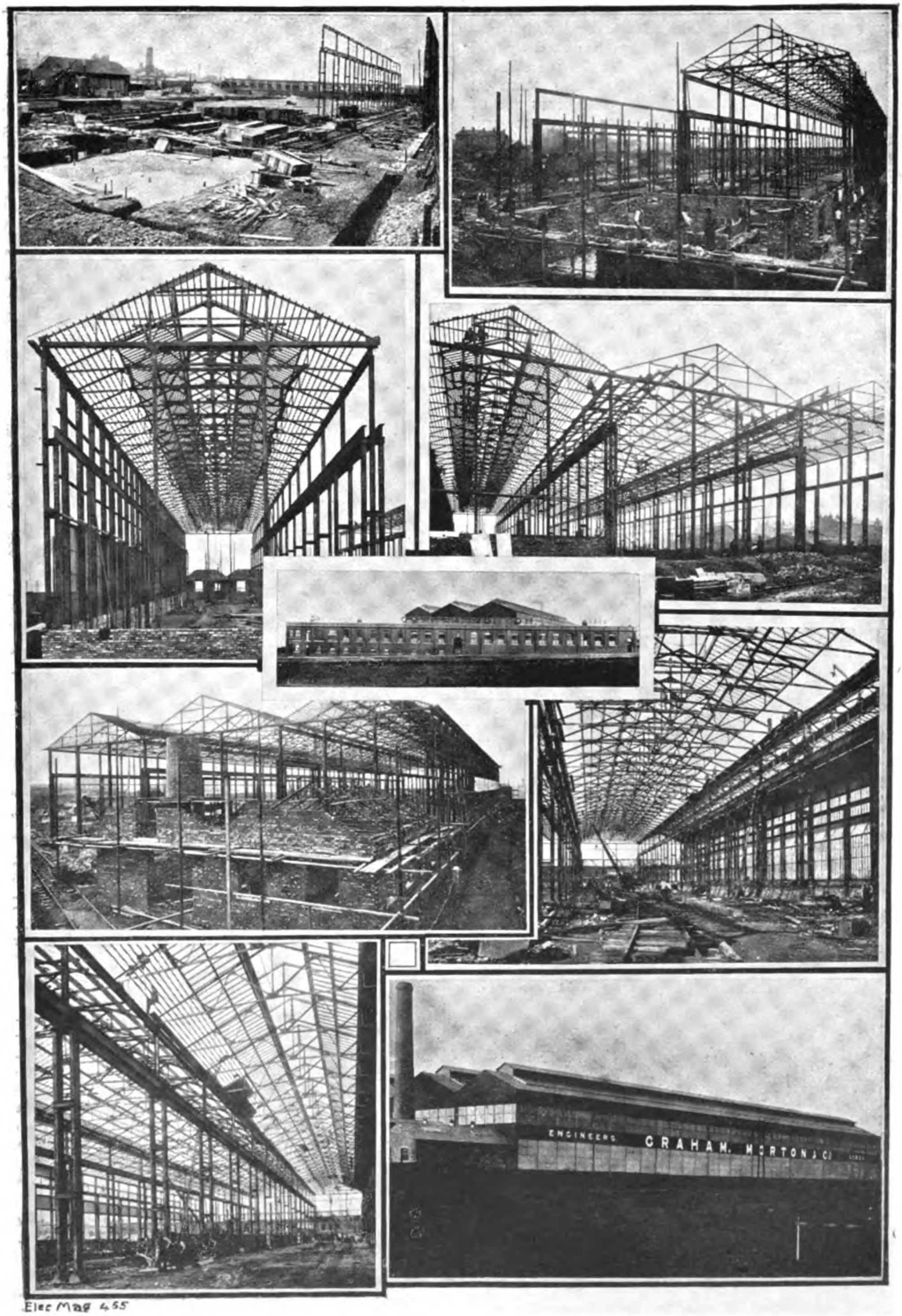
In our last issue, in opening this section, we referred to the electrical driving of workshops, dwelling upon the adherence of manufacturers to the steam engine as a source of power. The large new works of Messrs. Graham, Morton & Co., Leeds (to which we referred in our last issue also), are, we are pleased to note, no less up-to-date in their driving than they have been in their building. In giving some details of the driving of these shops, we think the occasion a fitting one to present our readers with the evolution of the works, from chaos to cosmos, in a "progressive" photograph illustrating the growth of the various buildings. We reproduce these photographs as a tribute to the enterprise of British engineers, and as depicting the smart manner in which a works can be erected when planned and conducted on modern lines. The view in the top left corner shows the state of affairs on July 13th, 1903, one month after operations commenced on a bare field; and the centre illustration depicts the works completed on November 2nd of the same year, or five and a half months from the date of starting operations. This brief period constitutes a record in the building of such an engineering works. We should have been surprised had any other method of driving than by electricity been chosen, but it was not to be expected that the builders of such works would be guilty of so grave an oversight. The machinery has been so arranged that it is driven in groups by motors of about 20 h.p. each, and for this work twelve motors are in use, in addition to the air compressing plant, driven by a separate motor of 30 b.h.p.

Electric Power House.
(Graham, Morton & Co., Ltd., Leeds.)

The electric cranes are provided with motors of a total capacity of 110 h.p. Many of the tools have been carefully grouped, and this arrangement permits of one department working late without the necessity of having all the shafting in the shop running. A noticeable feature in the driving arrangements is the absence of belting in the workshops, all the necessary belting being concentrated either near the wall or by the columns. In no case is belting placed where workmen pass, so that the danger of accident from this cause is quite remote. The power house, of which we give a view taken from the Souvenir presented to H.R.H. the Prince of Wales, is well situated, and the grouping of the tools for electric driving has been carefully studied. The total capacity of the installation is 490 b.h.p., power being generated by high speed vertical compound engines, with generators coupled direct. The switchboard is arranged that the generators may be run in parallel or independently, as required.

In the north-west bay are the fitting and turning shops, 200 feet by 40 feet, in addition to stores and tool room. In the centre bay are fixed the machines for the structural and plate work, the smiths' fires, and the steam hammers. In the south-west bay are the erecting shops for structural iron work and plate work. At the north-east end of the works is the pressing department, measuring 148 feet by 48 feet. On a gallery in the north-west bay are situated the idler roller shop and chain shop, covering an area of 120 feet by 40 feet. The total area of the works is 7,000 sq. yards. For the transportation of material five electrically-driven cranes are used, each being fitted with two 8 b.h.p. motors, one for hoisting and the other for longitudinal travelling. There is also one 5 h.p. motor for cross-traverse. The crab is arranged to hoist

10 tons at 7½ feet per minute;
6 tons at 9·1 feet per minute;
3 tons at 16·8 feet per minute.



THE BUILDING OF THE WORKS OF GRAHAM, MORTON & CO., LTD., LEEDS.
(The electric driving is described on p. 638 opposite.)

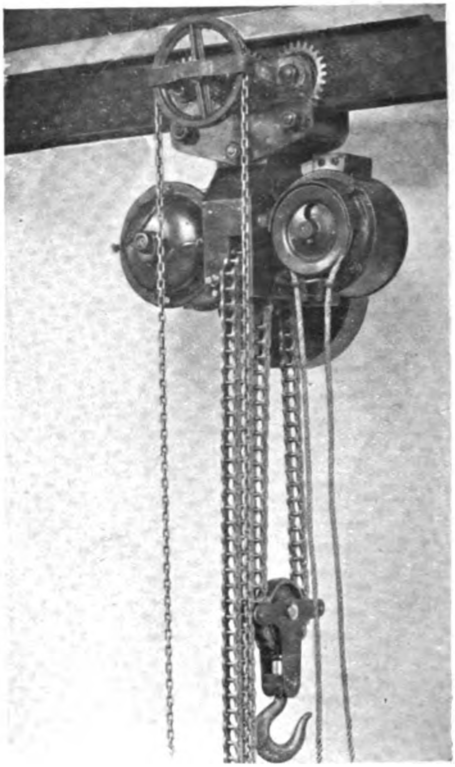
In addition there is an auxiliary hoist to lift two tons at 30 feet per minute, and a second to lift one ton at 40 feet per minute. Each of the hoisting and longitudinal travelling gears are fitted with electric brakes for automatically stopping the motors on the current being cut off. The controllers are of the tramway type, with magnetic cut-out and metallic resistance.

The cranes are arranged for a longitudinal travel of 250 feet per minute. The whole of the tools, with the exception of the air compressor, are belt driven from line shafts, each section of the works having its own motors. With the exception of the pneumatic drills, the whole of the tools are non-portable. The heaviest machine tools are in the structural iron work department, and comprise punching and shearing machines, girder bending or straightening machines, bending rolls and plate planing machine. These are all belt-driven, the line shafting running at a speed of 180 r.p.m., and this is uniform throughout the works.

None of the machines, with the exception of the air compressor and spiral coiling machines, have independent motors. Power is supplied as continuous current at a voltage of 220.

AN ELECTRIC PULLEY BLOCK.

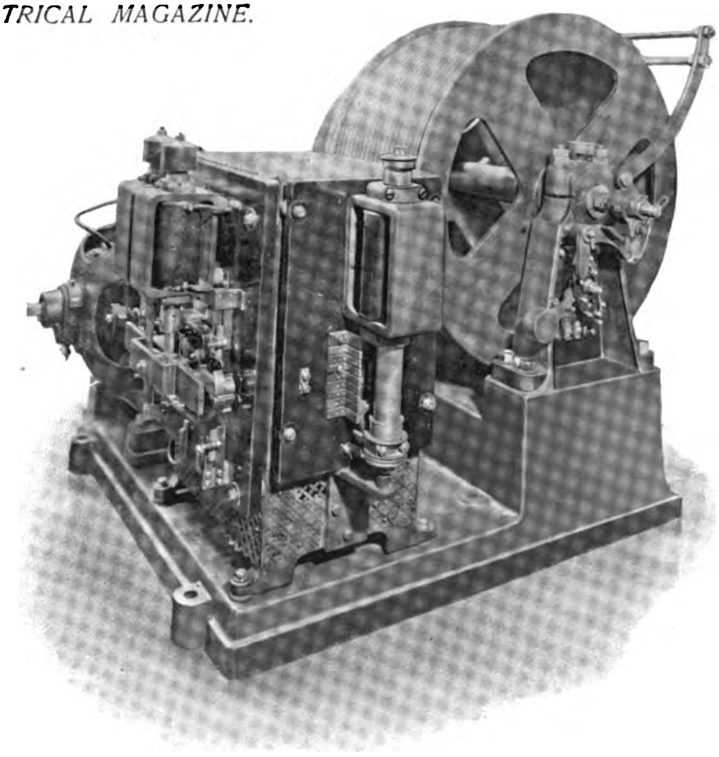
All engineers are familiar with the sight of one or two men "throwing their weight" on the lifting chains of pulley blocks, and how, despite their efforts, the load is raised but slowly. To obviate this tedious process, the Electromotor and Dynamo Co., 15 Gray's Inn Road, W.C., have introduced a neat electric pulley block, an illustration of which we give herewith. We examined the apparatus at the company's showroom, and were much struck with its compactness, as well as the ease with which it was controlled. The controller is rope-operated, as will be seen from the cut; and the motor on the opposite side is worm-geared to the chain tackle. The type depicted is for use on a run-way, but a form is also made for hook attachment to any convenient spot. The block is made for lifts from ½ to 15 tons at any speed within reasonable limits required by the consumer. A reversing switch and an efficient brake are provided. In printing establishments, electric light stores and shops, strong, heavy goods in basements, etc., the device would prove specially valuable—of course assuming a supply is available. In the 2 tons size, we were informed that running 200 lifts per day, with energy at 2d. per unit, the cost would not exceed 3s. per week. We were also shown a very compact electric lift gear (which we illustrate p. 641). In addition to assembling the motor, its controller and the rope drum on one bedplate, special attention has been paid to brakes and precautions against accidents. An electric brake comes into operation for ordinary stopping purposes, and, should the rope break, a safety catch is released, and a d.p. switch thrown out by a weighted lever. This action is primarily effected by the falling of the lever (seen at right of rope drum), this lever being normally raised by the tension of the main rope. The switches, both main and control, are electrically operated and controlled from a small switch in the lift car. Provision is made for a tappet to strike projecting arms on this switch spindle, to stop the lift at both limits of its travel. At the recent Printers' Exhibition, Agricultural Hall, this firm was awarded silver medal and 1st class certificate, also bronze medal, for its exhibits.



Electric Pulley Block.
(Travelling form)

A NEW REVERSE CURRENT RELAY FOR D.C. CIRCUITS.

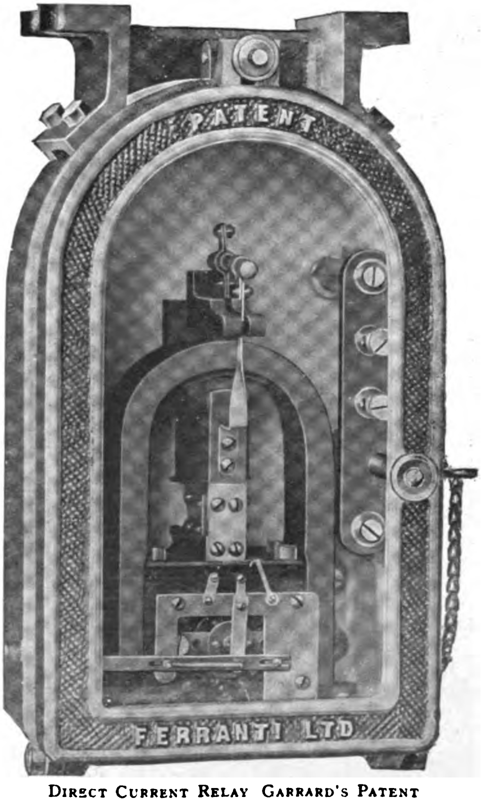
For protecting direct current generators and ensuring immunity from discontinuity of supply, circuit breakers, which isolate the machines from bus bars, when a reverse current of pre-determined magnitude flows through them, are to be preferred to all other protective arrangements. Several types of reverse current devices are now on the market, and, generally, they comprise two coils—one connected in the main circuit, and the other as a shunt across the bus bars. These have the disadvantage that the current at which they operate varies with the bus bar volts. The adjoining cut illustrates a reverse-current relay recently put on the market by Messrs. Ferranti, Ltd. (Garrard's Patent). It consists of a moving coil polarised relay, and the moving coil is operated by the fall of potential across the ammeter shunt. With current in the forward direction the contact carried by the moving coil strikes against a stop. On the passage of a reverse current of a certain magnitude, fixed by the set of the controlling spring, the moving coil rotates, and makes contact in the auxiliary circuit mentioned below. This



Electric Lift Gear.
(See under "An Electric Pulley Block" opposite.)

consists of eight Leclanché cells, and on being completed causes a small electromagnet to attract its armature. This latter closes a pair of heavy carbon contacts, which complete the circuit of the tripping coil of the circuit breaker. The object of the auxiliary circuit is to remove the sparking, due to the induction of the trip. coil, from the necessarily light contacts carried by the moving part of the relay proper. The trip coil is connected across the bus bars, and is constructed with such a factor of safety that, even if the bus bar volts should fall to $\frac{1}{8}$th of their normal value, it will be sufficiently strong to open the circuit breaker. The connections are so made that a coloured lamp is lighted immediately the relay operates, thus indicating at a distance which circuit breaker has operated. The relay is provided with a push button. On pressing this the device will actuate the circuit breaker. If desired parallel push buttons can be arranged at a distance from the switchboard, so that the circuit breakers can be operated therefrom. The whole relay can be placed at a distance from the main board if necessary. The relay is already in operation in several direct current supply stations in this country, where it has given satisfaction.

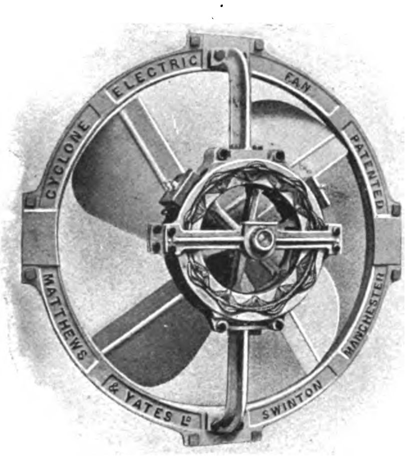
There are many interesting types of reverse current relay on the market, but central station engineers have so far done little but confess their want of faith in such devices. As opportunity affords we shall present our readers with descriptions of new apparatus of this nature, and in the Central Station Practice section shall record the results of operating such devices under running conditions.



Direct Current Relay Garrard's Patent

THE "CYCLONE" ELECTRIC FAN.

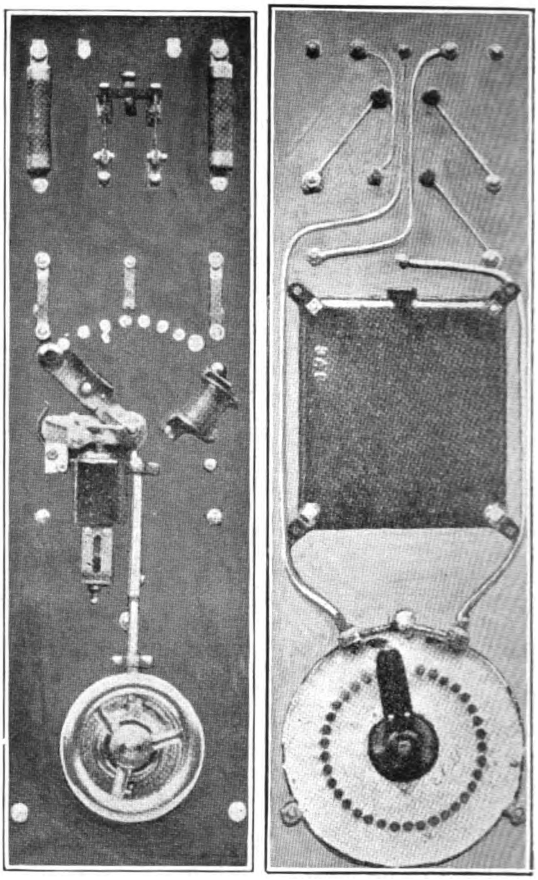
The electric fan has established itself in a position whence it seems to defy competition, and its popularity is fully evidenced by the many designs on the market. We illustrate this month one type of many manufactured by Matthews & Yates, Ltd., Swinton, Manchester, that depicted being for alternating current work. This firm has made a.c. fans for many years past, but the design in question has been introduced to enable the fans to be run at higher speeds with greater economy. The motor is of the simple induction type, without commutator or brushes. It is fitted with oil ring lubricators, and may be run in out of the way places with little or no attention. These fans, with a number of others, are on view at the Bradford Exhibition.



"Cyclone" Fan, Driven by A.C. Motor.

A NEW FORM OF MOTOR STARTING PANEL.

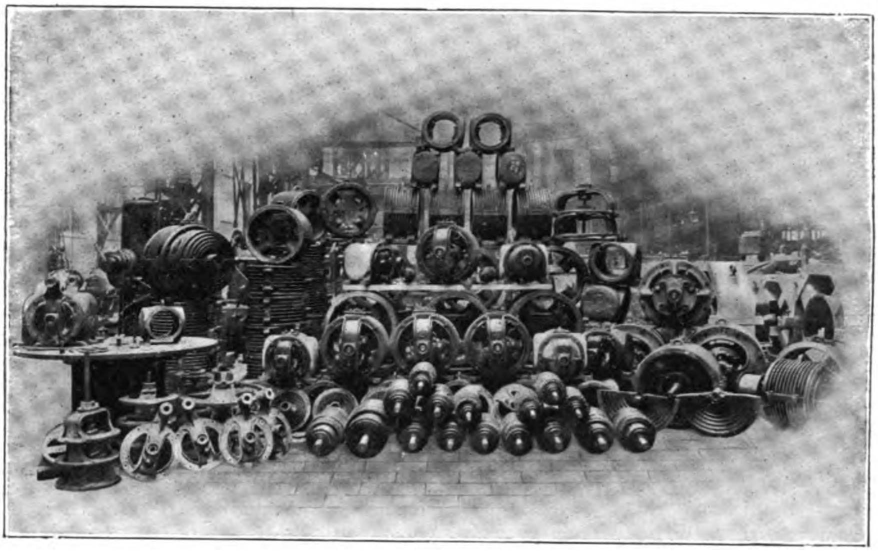
Messrs. Geipel and Lange are introducing a new form of motor starting panel, of the Ward-Leonard type, which embodies the latest improvements on their apparatus. From the illustration it will be seen that this panel carries upon it:—1 D.P. switch; 2 S.P. fuses; 1 motor starter; 1 field rheostat. The motor starter is of the well-known S.K. "Fool-Proof" type, fitted with a "no-voltage" release, opening the circuit breaker independently of the contact arm, and thus preventing the resistance being cut out too rapidly. This circuit breaker operates also at any time while the motor is running should the current become excessive, thus affording complete protection against carelessness and ignorance, as well as accidental overload. It is becoming a standard clause in the specifications of consulting engineers in this country, that a certain amount of speed regulation shall be obtained on the motor by one of the fields, and this particular type of panel is arranged that the field rheostat, connected to one of the fields, shall introduce sufficient resistance step by step, over 35 contacts, to cause the required acceleration. In order that the motor shall not be started up whilst the field is not fully excited, owing to the resistance having been left in circuit accidentally, an inter-locking lever is provided by which the starting arm is prevented from moving until all the resistance has been cut out of the field. The Ward-Leonard Co., whose agents are Messrs. Geipel and Lange, of 72a St. Thomas' Street, have also standardised a number of interesting rheostat panels, to which we shall refer in a future issue.



Front and Back Views of Motor Starting Panel.

STEEL CLAD MOTORS.

The necessity for reliable motors to work under every possible condition has long been felt, as with such a motor the sphere of electricity, as motive power, may be considerably extended. We illustrate a group of special steel clad motors, the

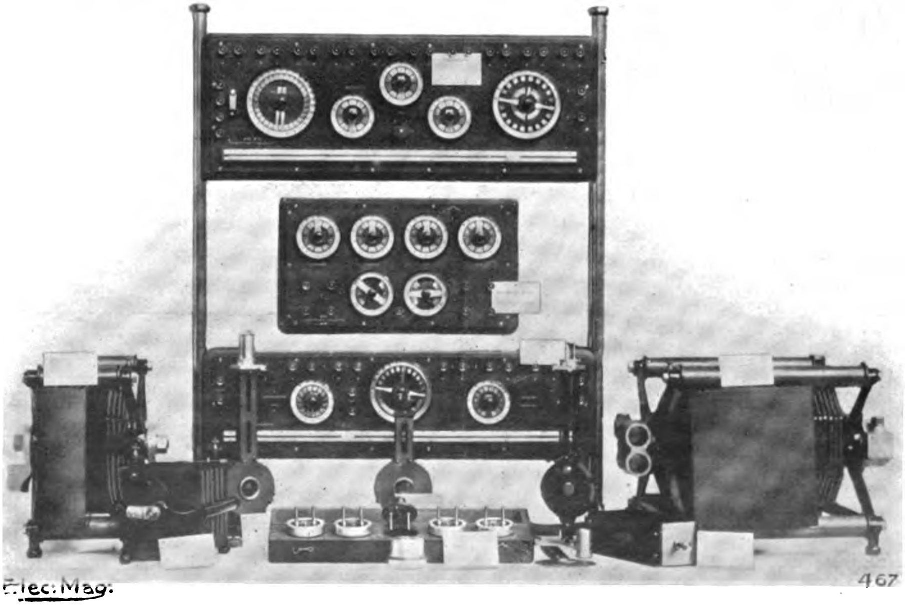


GROUP OF STEEL CLAD MOTORS AND PARTS.

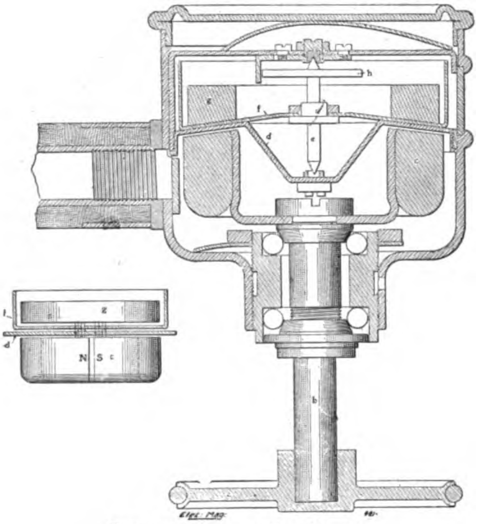
product of Mather & Platt, Ltd., Salford. An inspection of the various frame types will explain the forms in which these motors are supplied—(a) open, (b) protected, (c) dust and flame proof, (d) entirely enclosed and air tight. In the c and d types, special and extra special woven wire guards are placed over the open ends, and in d type special end covers are fitted, as can be seen on the left of the group. The motors are built in sizes from 1 to 90 h.p., and for speeds 1,440 to 115 r.p.m.

A NEW CUT METER FOR MACHINE TOOLS.

THE Warner Instrument Co., of Belois, Wisconsin, have recently introduced a neat instrument for indicating the speed of work or tools in machine shops. The principle is quite new for such tools, and we refer our readers to the adjoining section, which will help to make the design clear. A rubber tyred wheel *a* through the shaft *b* rotates



MESSRS. CROMPTON & CO.'S EXHIBIT OF INSTRUMENTS FOR THE ST. LOUIS EXPOSITION.
(*See last issue, p. 459.*)



SECTION THROUGH CUT METER.

the permanent magnet *c* at the speed of the tool or work to be measured. The magnet *c* is in ring form, as shown in detail at left of illustration. Above the magnet is a partition *d*, supporting the lower bearing of the shaft *e*, carrying a thin aluminium disc *f*, above which is a soft steel ring *g*. In the detailed view to the left of the cut will be seen the direction taken by the lines of force from the permanent magnet, the revolution of which sets up currents in the disc. This latter tends to revolve, against the action of a spring *h*, and carries with it a needle moving over a graduated scale. The movement of the disc is directly proportional to the speed of the magnet, and therefore to that of the work. The spindle runs in ball bearings, and the disc is supported in sapphire jewels. The external case is threaded to permit of its adjustment in relation to the disc, the latter being approached or receded to or from the revolving magnet. By this simple adjustment the instrument is calibrated. Speeds to 250 ft. per minute can be normally recorded.

Electro-Enamel, Insulating Varnishes, etc.

IN the days of low voltages and poor insulating materials, little or no attention was paid to the production of enamels and varnishes suitable for coils, bobbins, etc. Higher pressures and heavier currents have, however, compelled attention to these items, and prominent among firms producing such materials is B. Paege & Co., Kaiserin Augusta Allee, Berlin, who claim precedence among Continental makers, as making special study of these important electrical accessories. What would engineers in the eighties not have given for an insulating varnish, a thin layer of which would withstand a piercing test of 10,000-14,000 volts, or of a varnish equal in resisting properties to a similar thickness of mica? Messrs. Paege have had a series of important tests made by the Imperial Physico-Technical Institute, Charlottenburg, together with an interesting booklet, which should be in every winding shop. From this we find that many specialities are produced by the firm, chief among which is electro-enamel, which is a heat radiator, water and acid proof, and is specially suited for electrical plant and apparatus. There are also "Planté" enamel, quick drying, with polished surface for metals, wood, stone, etc. Elastic varnish, smooth, flexible, acid, alkali and damp proof; and "Franklin" insulating adherent, tested on canvas to 8,400 volts. This latter is suitable for sticking insulating materials.

A New Porcelain Ceiling Rose.

A NEW ceiling rose, calculated to cheapen the cost of wiring when conduits are used, has lately been introduced by Messrs. Dorman & Smith, of Ordsal Works, Salford. The rose is of porcelain, made in one piece only, and, as the terminals are sunk into the porcelain on the inside, there is no necessity for a separate cover. The terminals are large and substantial, and suitable for looping through for the main wires to be carried on to the next ceiling box without break. The pendant flexible cord is first attached to the terminals through a deep V-shaped gripping arrangement in the ceiling rose. The rose, with its pendant flexible, is then attached to the jointing-box by two screws.

High Voltage Oil Switches.

THE Stanley Electric Manufacturing Co., Pittsfield, Mass., have introduced recently a line of high voltage switches which present many interesting points. A special switch for 60,000 volt circuits comprises a separate tank per pole, the fittings for each switch being mounted on a C.I. plate, forming a cover for the tank. Long porcelain insulators with many corrugations protect the leads, and a special mounting admits of the horizontal operation of the switch. Special shunt contacts prevent the maintenance of an arc across the main contacts. An oil level indicator is fitted, which automatically closes a pilot circuit, ringing a bell should the oil fall below a certain level. Each switch is tested at 120,000 volts, and in operation the tanks and covers are carefully earthed.

Ferranti A.C. Meter.

WE understand that Messrs. Ferranti's A.C. meter, described in our first issue, pp. 77-8, has now received the official approval of the Board of Trade. Mr. F. Barnes Spencer, Donnington House, Norfolk Street, W.C., is the sole representative for the sale of both D.C. and A.C. meters made by Ferranti, Ltd.

OUR NEW VOLUME.

This number completes the first volume of "The Electrical Magazine." In our July issue, commencing the new volume, we shall introduce new features, and throughout each issue, but we shall specially treat with the Manufacturers' Section. Among other things, we shall publish monthly a full page photograph of some standard piece of electrical apparatus, representing the work of electrical engineers in all parts of the world. Manufacturers are invited to forward good photos for consideration in this respect.

Central Station Practice

The Central Station engineer has not had his due meed of attention in periodical electrical literature. This section, conducted by a gentleman who has made station work a study, will be open to all Central Station men, and in co-operation with a number of them, the Associate Editor intends presenting matter which will be of considerable interest and value to the community affected.

* * *

Mechanical Stokers.

By F. H. WHYSALL, A.I.E.E.

It is not intended, in this article, to deal with the genesis of "Mechanical Stokers," or to illustrate their evolution from their birth in 1819, under the auspices of Mr. William Brunton at Birmingham, but rather to miss all this and deal with them as they are to-day.

The writer holds no brief for any particular form of stoker, and is of the opinion that their successful working, or otherwise, depends entirely on local conditions, and the degree of intelligence with which they are worked and cared for.

The utility of "mechanical stokers" has been the subject of much controversy from time to time, both in the technical press and at engineering gatherings. It is by no means a subject that is yet worn threadbare. Albeit a large number of mechanical stokers have been invented and put on the market, the makers claiming a great deal for them both on the score of economy and smokeless fuel consumption.

Many have received exhaustive consideration at the hands of engineers, and a number of sound and well tried types have been successful in permanently establishing themselves as a commercial success.

In the early days, the inventor of a mechanical stoker was met with much opposition, and was often told that more men were required to look after the stokers than to fire the boilers. The men themselves fought it, as they usually do fight what they consider a labour saving device. As a consequence, many good ideas and much energy were wasted.

The desire of communities for a purer atmosphere led to prosecutions for smoke nuisance, and perhaps did much to bring about the satisfactory condition of an apparatus of this kind to-day.

The utility of a mechanical stoker consists in the mechanical feeding, at regular intervals of such small quantities of fuel that the time between each charge allows the gases to effect complete combustion, obviating any loss in the admission of too much air, through opening the fire doors as is the case in hand firing, and in the reduction in manual labour. At sea, one man is expected to hand fire from four to six furnaces, and practice on land is perhaps slightly under this. An exceptional fireman has been known to fire by hand 15 tons of coal per shift of 12 hours as a regular day's work. On the other hand, two men have been known to look after 22 4ft. 6in. × 9ft. furnaces, with the aid of mechanical stokers and coal conveyors. These are exceptions, but they serve to show the saving in labour.

As to smoke consumption, there is now no doubt that the modern mechanical stoker accomplishes it effectually, when intelligently worked.

Another advantage of mechanical stokers is that they make possible the economical use of very low grade fuel. Their use is not, however, the best for all cases, as there are disadvantages under certain circumstances. For instance—these disadvantages have so far, with the exception of a few experiments, kept them out of the hands of marine engineers. In this case the obstacles are:—

1st. That the quality and size of coal supplied to ships varies in different parts of the world, and some kinds—say anthracite—require very special treatment, different from that of a mechanical stoker.

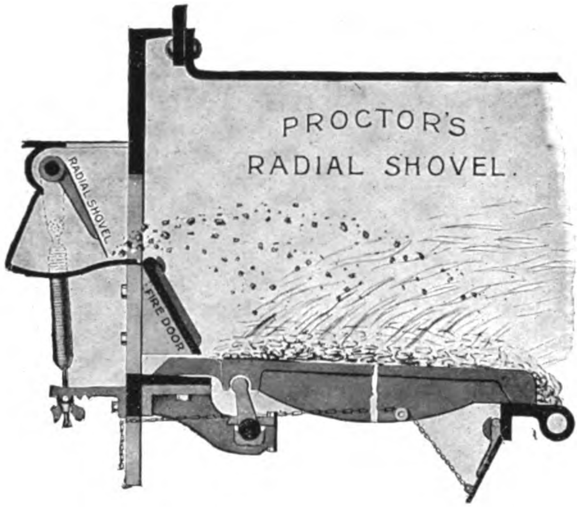


Fig. 1. Proctor's Shovel, Showing the Different Throws.

2nd. The question of size would necessitate a crushing plant.

3rd. The coal conveying machinery and stokers would increase the possibility of breakdown.

And 4th. There could be no saving in labour, as enough men would have to be carried to hand fire the boilers in case of breakdown.

Some of these objections apply to shore jobs. In electricity works far from the coalfields, where it pays to burn a high grade fuel on account of the high transport rates, or where the coal obtainable is unsuitable. Also where coal and labour are alike exceptionally cheap.

Roughly speaking all bituminous coals are suitable for mechanical stokers, and anthracite is unsuitable.

Anthracite has a higher specific gravity than bituminous coal, contains less volatile matter, more carbon, less earthly matter, and burns best undisturbed. It also clinkers badly, fire bars get hot, and fires require much picking and cleaning.

Mechanical stokers may be classed under the following heads:—

COKERS, UNDERFEED COKERS, AND SPRINKLERS.

Opinions differ as to the relative merits of one type over another, but the writer would claim that circumstances are in a large measure the cause of this.

For burning very low grade fuel, and where boiler power is ample, the sprinkler has a great advantage. But when overworked, this type is not so smokeless as others, and under forced or induced draught, if the fuel is very fine, a large portion is whisked up the stack without being consumed, and showered on the surrounding neighbourhood in the form of very fine coke, in spite of elaborate and expensive arrangements to trap it.

Where smoke consumption is an important point, cokers are generally preferred. Underfeed cokers are, of course, included under this head. It is also generally considered that cokers and underfeed cokers require less attention than sprinklers.

Note.—Forced or induced draught also renders an expensive stack unnecessary. A very short iron one only is required.

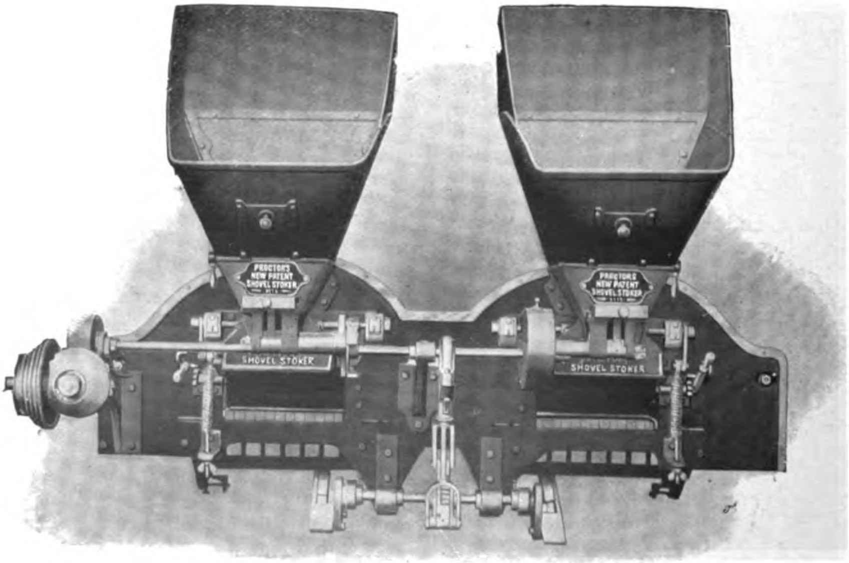

PROCTOR'S NEW PATENT SHOVEL STOKER
SHOVEL STOKER
PROCTOR'S NEW PATENT SHOVEL STOKER
SHOVEL STOKER

Fig 2. Proctor Stokers, as Attached to Boiler.

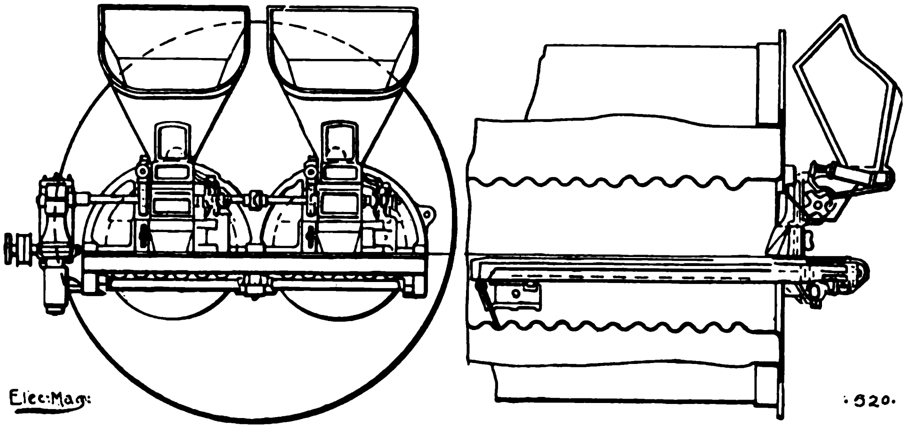


FIG. 3. BENNIS STOKER ON LANCASHIRE BOILER.

Where space is an object and forcing desirable, forced or induced draught is found to be advantageous, or, where there is a very fluctuating demand, a very efficient means of regulation. Under ordinary circumstances natural draught is the most economical. For forced draught, it is claimed that there is not so great a loss through the admission of air through accidental openings to the furnace as with induced draught, but at the same time, induced draught is perhaps more easily applied.

The writer would advise steam users to be very circumspect in the use of steam jets, and as an example gives the results of a recent and careful test of the steam consumption of jets at 100 lbs. pressure above atmosphere.

Three sizes were tried, $\frac{1}{8}$ in. diam., $\frac{1}{4}$ in. diam. and $\frac{5}{16}$ in. diam., with ordinary belled nozzles.

The consumption was found to be as follows:—

For $\frac{1}{8}$ in. diam.	...	110 lbs. per hour.
,, $\frac{1}{4}$,, ,,	...	330 ,, ,, ,,
,, $\frac{5}{16}$,, ,,	...	435 ,, ,, ,,

Steam jets are often used to keep bars and dead plates from burning. But it will be found in most cases that an experienced fireman can work without their aid. And if only 50 lbs.* an hour are used for this purpose per boiler, a considerable saving would be effected on 12 months' working with a large battery of boilers.

Coal consumption. 30 lbs. per sq. ft. of

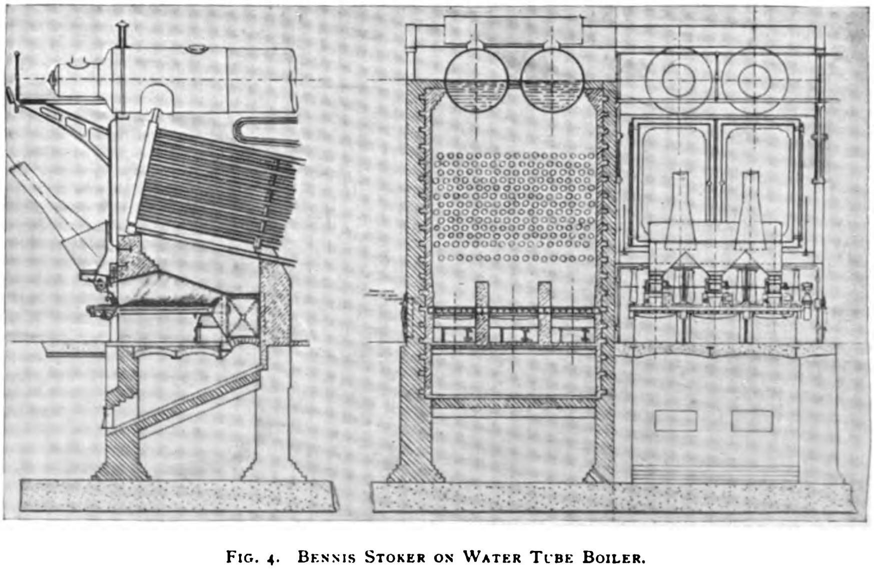


FIG. 4. BENNIS STOKER ON WATER TUBE BOILER.

---

* This has been found to be a minimum by experiment.

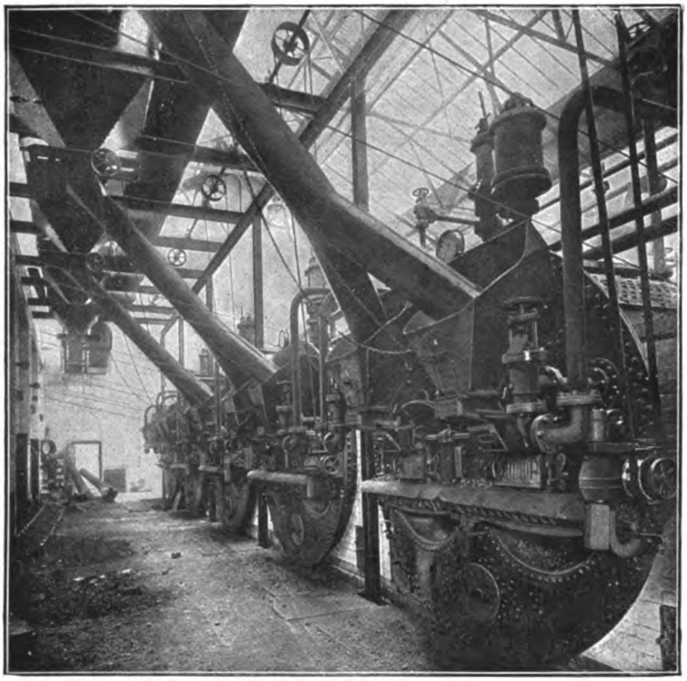


FIG. 5. BENNIS STOKERS AT DUBLIN ELECTRICITY WORKS. [*Photo Lafayette.*

grate is a fair average. To burn more is possible, but often more costly. Some makers claim a great deal on this score, but it is only of value where forcing is essential.

Driving Power. This is so small as to be almost negligible, ½ h.p. per boiler is often estimated, but in practice it is found under ordinary conditions much less. Motor driving is preferable where there is an electricity supply, if it be only for the sake of the tell tale ammeter in circuit, which shows at once when anything is wrong by the abnormal current indicated.

Ash pits. These are often a source of loss if not carefully blocked to the passage of cold air. As many are made without doors it behoves the fireman to see that they are carefully closed with ashes and flue dirt.

SPRINKLER STOKERS.

Proctor's Patent "Shovel" Stoker and Bars. This stoker is manufactured by J. Proctor, Ltd., at Hammerton Street Iron Works, Burnley. Fig. 1 shows a perspective view of stoker and bar motion; Fig. 2 shows a sectional elevation. This stoker has been designed to imitate good hand firing, without its defects. To fire lightly and often, keeping the fires regular and even, are the principles of its construction.

These results are obtained by the action of a spring shovel and tappet, the tappet having three different throws. An important feature is the form of shovel invented by Mr. Proctor. The quantity of coal to be burnt is controlled by simply adjusting the regulating screw of the ram (which supplies coal to the shovel), to feed from, say, 2 cwt. per hour per furnace up to any quantity that the draught will consume. To assist the shovel in distributing the fuel equally over the fire bars, it is made V shaped, to cover the whole length of the fire grate. The tappets are placed at different distances from the centre of the lantern wheel, which gives more or less traverse to the shovel, thus varying the tension put upon the springs, and allowing the coal to be thrown to any part of the grate. By the combined arrangement of lantern wheel and scroll, it is possible to have them working constantly in a bath of oil—a great advantage where there is most wear and tear.

The Bennis Sprinkling Stoker, manufactured at Bolton, is widely known. Its special feature is the shovel and gear. This consists of a long coiled spring, enclosed in a cylinder, and pressing on a piston. The spring is used merely to propel the shovel forward, and any remaining force is taken up by the air cushion, thus avoiding jar. The fuel falls from the hopper, in front of a simple pusher plate contained in a cast-iron feed box, and is pushed on to a flat plate, termed the shovel box. The fuel is regulated by a cam on the driving shaft. The coal is shot into the fire by the shovel, the cam drawing back the shovel, having four varying lifts. The fuel is thus scattered on the fire in four divisions. It is made with tubular fire bars, and is self-cleaning. The bars move into the fire together, and are then withdrawn singly by cams carrying the clinker to the back, where the bars are higher. The clinker falls where its heat is given up to the boiler. This cleaning arrangement is a valuable feature.

Figs. 3 and 4 depict Bennis stokers fixed to Lancashire and water-tube boilers respectively. The chief points of interest are here emphasised. Fig. 5 illustrates a battery of boilers fitted with these stokers at Dublin Electricity Works, where a large lighting load is dealt with.

(To be concluded.)

By subscribing annually to "The Electrical Magazine," you secure special advantages. Send your order at once for the next volume.

Notes on the Working of Central Station Plant.—I.

By F. H. CORSON.

In the following articles an attempt will be made to deal—from the point of view of efficiency—with some of the problems occurring in the actual use of generating plant in present day central stations. It is only by regarding the work of generation of power as a series of operations, each with its own difficulties, demanding careful and thorough investigation, that the highest final results can be obtained from the entire plant, and this is the basis on which these notes have been written.

COAL AND COAL TESTING.

In the case of most central stations, the fuel bill represents more than half the generating costs, and it is proposed to deal first with this item, as regards the selection of the most suitable fuel, and, when chosen, how to use it to the best possible advantage.

The considerations involved in the selection of the coal will be not only first cost, but calorific value, percentage of incombustible matter, smoke, ease of handling, effect on firebars and stokers, and available supply. The conditions due to the season of the year, and the consequent alterations in the character of the load, will also affect the decision.

In most towns the daily load factor is poor, and boilers must be banked during a great portion of the day so as to be available for the heavier load during the remainder. The summer load is usually much less than the winter load, and boilers are entirely shut down for six months of the year, and, consequently, are making demands on the capital charges without bringing in any revenue. To obviate this, it will usually be profitable—if the generating station is within reasonable distance of the coalfields—to contract for two qualities of coal, from one of which the maximum duty of the boilers will be obtained, while the other may be of a cheaper grade for use during periods of light load when the boilers can be steamed easily.

The price of coal does not vary proportionally to its calorific value, and a cheap coal can generally be obtained to give results which more than compensate for the additional labour entailed by its use. In determining the most suitable coal, samples of the various coals under consideration should be carefully tested by means of some form of calorimeter. This apparatus, which is too well known to need description, is shown at work in the illustration. The heat imparted to the water is a measure of the calorific value of the fuel, and it matters little whether the instrument reads correctly in British thermal units or not, as, whatever the error, the results from different fuels will be relative to one another.

The ordinary form of calorimeter is only adapted to the combustion of some two or three grammes of fuel, and the difficulty of obtaining a sample representative of the coal in this small compass is obvious. Better results are obtained by the use of an instrument to burn a larger quantity—say, one ounce—and such an apparatus can be made at a trifling cost. The indications of the calorimeter, however, must only be regarded as a preliminary test, although a most useful one, showing which coals to reject without further consideration. They give no data as to the behaviour of the coal in a boiler furnace: *e.g.*, whether it is smoky or not, the percentage of ash, and whether it will burn freely or clinker on the bars.

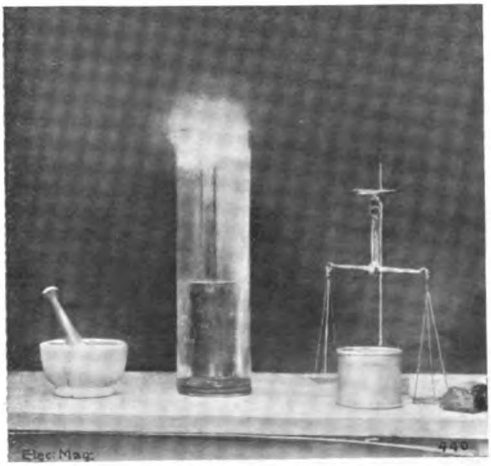
With a view to deciding these points, the three or four coals which appear most suitable from the calorimeter tests should be subjected to an actual running test of a week each, taking careful note of:

(a) The amount of coal used.
(b) The percentage of ash produced.
(c) The units generated; or, better still, the water evaporated.
(d) Any climatic conditions likely to modify the results.

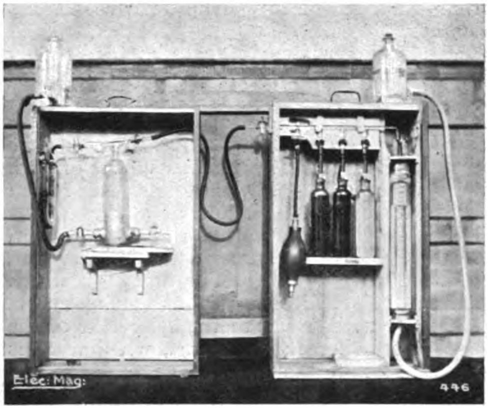
To avoid any possibility of the personal equation of the fireman leading to different results, the men should be kept on the same shifts while the tests last. These methods will give a very good idea of the results which may be reasonably expected to accrue under actual working conditions.

THE COMBUSTION OF FUEL.

Having selected the coal, the methods of so using it as to obtain the highest economy must be considered—a matter which has been somewhat neglected. So long as the coal has



CALORIMETER IN OPERATION.



C O_2 Apparatus.
(*The Smoke Preventer Co., Blackburn.*)

been burnt, little investigation has been made to determine whether the work obtained from it were the greatest possible, and whether the existing conditions were conducive to economy of combustion. Boilers lightly worked under excessive draught, or heavily pressed under draught too poor for thorough combustion, are frequently seen. In the one case, a large quantity of excess air is drawn through the fire, thus lowering the furnace temperature; while in the other, the air supply is insufficient to burn the coal perfectly, and the fire must be constantly stirred about, entailing frequent opening of the furnace doors. On either hand the work obtained from the coal is greatly diminished.

The correct draught, thickness of fire, and most efficient duty of the boiler with a given class of coal, are matters which can only be arrived at by analysis of the flue gases. The products of the combustion of coal are, in the main: Carbon di-oxide (CO_2) and carbon mon-oxide (CO). If 1 lb. of carbon be burnt with sufficient air to form CO_2, some 14,500 heat units are evolved; if the supply of air be so restricted as to form CO, combustion is effected with an evolution of only 4,400 British thermal units. From this it is at once seen that any formation of CO militates strongly against economy. The carbon in the coal, however, may be totally converted into CO_2, and the results still be bad, owing to an excessive admixture of air, which, while preventing the formation of CO smoke, lowers the efficiency (as shown above). The losses in economy accompanying varying percentages of CO_2 may be given in the form of a table.

From the foregoing, the necessity of analysing the flue gases is obvious, and any apparatus (at a reasonable price) which can effect an increase of economy of 30% to 50% will defray its cost in a very short time by the saving in fuel.

Such apparatus is on the market in various forms, either for taking isolated samples of the gases and analysing these, or arranged as a recorder for keeping a permanent register of the working of the boilers. An example of each type is shown in the illustrations.

It will be found a very profitable arrangement to establish the CO_2 recorder as a permanency in the boiler house—in view of the firemen—and to arrange a bonus system on the basis of the best record each week or month. A fireman can then, at all times, know exactly the value of the work he is doing, and, if his results are bad, can take immediate steps to remedy the defects.

The system of giving the men a direct financial interest in the saving of fuel is to be commended, and this can be done much more easily and equitably by taking the CO_2 record as the standard, than by merely calculating on the weight of coal per unit generated. This latter method is full of difficulties and open to many objections, on account of varying circumstances, which may make it impossible for one fireman—though, perhaps, the better workman—to compete against another working under better conditions. Thus, unfavourable weather may cause poor draught or wet coal, and any alteration in the steam consumption per unit generated, from the use of different sections of the plant, will at once change the basis of calculation.

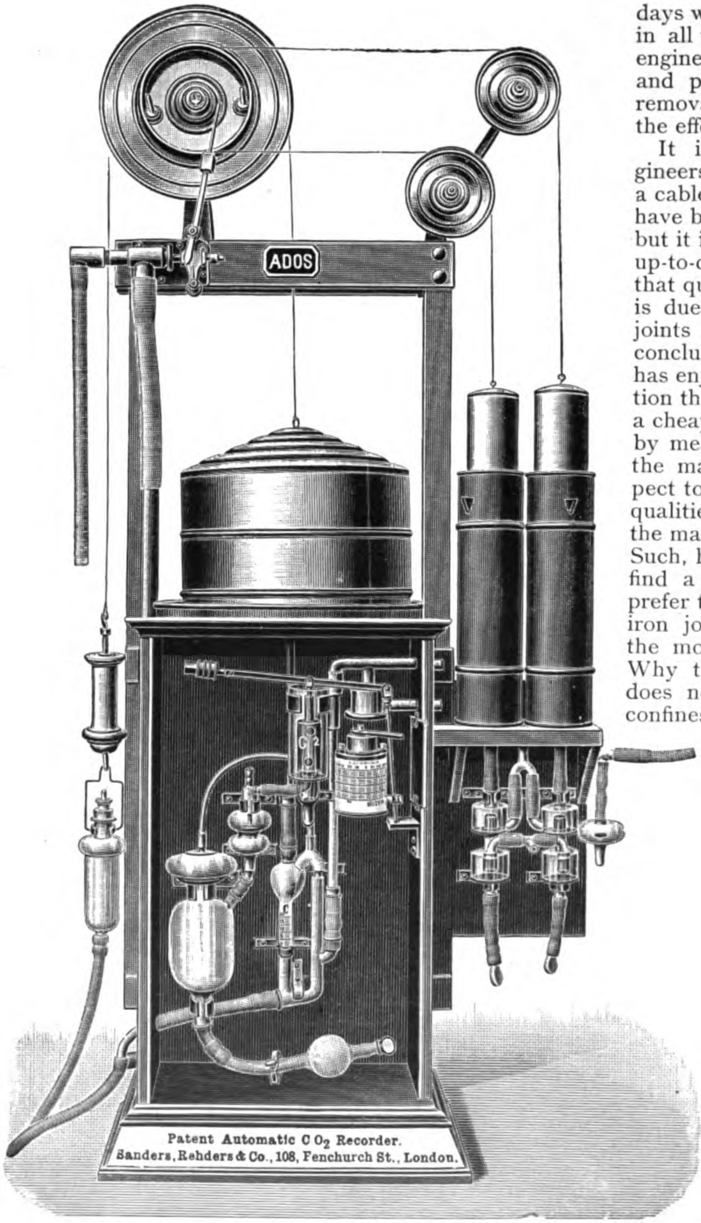
The economic results obtained vary slightly from week to week, and without such a record the engineer cannot be certain whether a loss of efficiency is attributable to carelessness on the part of workmen or to external causes—a question easily answered by inspection of the CO_2 chart.

On these lines, however, he may satisfy himself that, whether with favourable or unfavourable conditions, his results are the best to be obtained under the circumstances, and as he cannot, in the present state of scientific knowledge, modify the vagaries of our climate, he can rest assured that he is, at any rate, making the best of them.

[*These notes will be continued next month, and each instalment will be an article complete in itself.*—Ed.]

Central Station Engineers can find all they require regarding the chief articles directly affecting their interests, by reference to the "World's Electrical Literature" section, at the end of the Magazine

CO_2 in flue gases % ..	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Heat wasted %	90	60	45	36	30	26	23	20	18	16	15	14	13	12


ADOS
Patent Automatic C O$_2$ Recorder.
Sanders, Rehders & Co., 108, Fenchurch St., London.

Ados CO$_2$ Recorder. *(See p. 650.)*

"Faults" on Underground Mains: a Remedy.—I.

By JAMES CLEARY.

Much has been written—good and otherwise—on this most important subject, the removal of "faults" from underground cables, but little has been said as to the best means of preventing them. In these days when the chief aim is efficiency in all things, it behoves the mains engineer to look to his armour, and pay more attention to the removal of the *cause*—rather than the effect—of the "fault."

It is an axiom with cable engineers, "that the weakest points in a cable are the joints." This may have been the truth a decade ago, but it is not the case to-day on any up-to-date net-work. Considering that quite 75% of "fault" trouble is due to moisture creeping into joints of the iron-box type, it is a conclusive proof that the iron-box has enjoyed a much greater reputation than it deserves, and now that a cheaper and more efficient method by means of lead-wipe joints is on the market, one would hardly expect to find the "fault" producing qualities of the former preferred to the many advantages of the latter. Such, however, is the case, and we find a majority of engineers still prefer to risk the limited life of the iron joint box, rather than adopt the more perfect lead-wipe system. Why this should be so the writer does not attempt to explain, but confines himself to actual experience, and will endeavour to demonstrate *some* of the weak points to be found in iron boxes for underground joints, at the same time showing that the remedy may be found in the system here described.

Much credit is due to manufacturers for the many improvements made during recent years in iron-box joints, and some are being made to-day which have many good points. It is for the mains engineer to find the defects, and from him should come suggestions for improvements, as he, from daily experience, has opportunities of observing faults taking months or years to develop. The latest type of this class of joint box leaves much to be desired from a mains engineer's point of view, and it is with this the writer first intends to deal; and as the single cable solid system is at present much in favour with engineers, the writer will take as an example a three wire house service joint of the latest type.

All engineers are familiar with the trying conditions under which a jointer has to perform his—all but impossible—task. More often than not the only tools he can use with effect—owing to want of space—are a small cable saw, a hack knife and a hammer, with which to cut away the soddened wood trough to the required length, to fit the box *exactly*. They will probably agree with the writer that the best efforts meet with but poor results, and in the majority of cases are only a make-shift at best, as only by a judicious packing of earth and other material around the ends of the trough can the compound be kept in. Having *overcome* this difficulty the jointer *fills* his box, bolts down, rams in earth, and the job is finished. These are briefly the average conditions under which the job is done, and the last state of that joint is certainly worse than the first. The shrinkage of compound which takes place as the box cools, leaves an objectionable space for lodgment of water, and if one or more of the nine cable holes in the box does not afford a passage for moisture, the lid will certainly do so, a cable trench being one of the best courses for any surface or other drainage.

Take a similar three wire house service, but use a good lead box—not the antiquated lead sleeve—wiped on to the cable for each joint. The box is in two halves, the upper being made to the lower, and forming a neat longitudinal rebate joint, which is tapped close with small hammer, the joint being wiped with plumber's metal, by means of a blow-lamp. Also both ends and tee on to the cable are wiped in the same manner, and the box filled with a good solid compound—not resin, oil or any other liquid insulator. The pouring in hole is then capped up with a lead disc and wiped—thus overcoming any possibility of water getting in. After this, all joints are filled in troughing solid with the cables, and the job is perfect, mechanically and electrically, as well as being water-tight—the object aimed at. It takes less time, costs *not more than half*, whilst all the defects of the former system are overcome, and the joint, instead of being the weakest point in the cable, is the strongest. Of course the same shrinkage of compound takes place, but not with the same disastrous result, as *the water cannot get in*, and if the cable gets out of level through subsidence or any other cause, the joint does not suffer in the least.

Many engineers are prejudiced against a lead-wipe system, owing to plumbing being necessary, or, having tried some of the obsolete methods with doubtful success, have given it up in disgust. The system advocated by the writer requires little plumbing, and he would be a poor jointer indeed who could not make a satisfactory joint with a few hours' practice, especially as most men are now familiar with the use of the blow-lamp.

The boxes are made to fit all sizes of cable, and when finished are torpedo shaped, about three times the size of the cable in the centre. The box is self-centering and practically falls into position, leaving but little to chance or carelessness on the part of the workman. The system here described is covered by patents, and for obvious reasons the name of the makers cannot be given here, but should readers interested in the matter desire further information, the writer would be pleased to pass on any enquiries to them.

In a future article the author hopes to deal with triple concentric jointing, and would remark *en passant* that it is with this class of cable the greatest success is achieved with a lead-wipe system of jointing. All the old difficulties are overcome, and joints are easily and *safely* made even on " live " cables up to 400 or 500 volts potential.

(*To be continued.*)

◆ ◆

CENTRAL STATION NOTES.

◆

Earthing the Neutral Point of Rotary Converter Plants.

It has been known for a long time that in three phase plants with earthed neutral points, breakdowns will occur much less frequently than otherwise. Some experiments made by Mr. P. Humann (*Elektrotechnische Zeitschrift* No. 18, 1904) on behalf of the firm of Felten and Guillaume, bear out the advantages of this course. In addition to the higher safety with respect to short circuit, the earthing of the neutral point will allow of any defect in the system being noted immediately as the phase concerned is short-circuited. On the other hand, the insertion of any safety apparatus against supertension is much simpler and much more efficient than in the case of the neutral point being insulated. A special advantage, however, is the fact that the loss of watts due to dielectric hysteresis is diminished to a material extent by earthing the neutral point. The earthing is best made from the machine house by means of a special conductor not too small in cross-section.

Voltage Disturbances when Paralleling Dynamos.

F. P. Wilde writing to the *American Electrician*, deprecates the use of a single three pole switch for paralleling dynamos, on account of the voltage disturbance set up by its use. He advocates three separate switches for positive, negative and equalizer respectively, the first and last of which are closed first and the negative last when paralleling. The incoming machine then has its series field paralleled with the running generators, and no voltage disturbance results when the negative switch is finally closed. The voltage adjustment is effected by the shunt rheostat. It is a common practice to supply a three pole switch for small compound generators, and where the trouble above referred to is experienced, such a switch should be divided as suggested.

The hundred and one difficulties met with in the workshop of the manufacturing electrician will be dealt with in this section, the object being to generate an interest among workmen and employers alike, which should prove of real practical service. The more intelligent artisans are moved to better efforts and closer interest in their work by the incentive which such a section as this presents to them, and who shall say what the reflex benefit to the industries of our country will be, if the idea of emulation takes solid root and is consistently and systematically encouraged? As a further inducement to workmen, prizes are offered for the best hints and suggestions submitted. No sketches will be too crude to receive consideration, as our own draughtsmen will specially and adequately treat any such drawings of an original character received. Any further details required will be furnished on application.

The Care of Electrical Apparatus.*

CLEANLINESS.—By far the most important element in the proper care of all electrical apparatus is that of absolute cleanliness. The fact that dirt is prevalent about a steel plant makes it of the utmost importance that electrical apparatus be cleaned frequently and thoroughly. Not only the vital parts, but all parts of all apparatus must be kept free from dust, scale, grease, oil and other dirt, to insure satisfactory operation.

Generators. With a direct-current generator the most essential condition, after cleanliness, for satisfactory operation, is that the commutator shall be in good condition. It must run true and be smooth. The surface should present a hard, dark, glossy appearance. Sandpapering is to be avoided unless necessary to avoid roughness. Never use emery cloth, The use of oil is objectionable, but an occasional touch of paraffin, just sufficient to stop "squealing of the brushes," is permissible. Sparking causes roughness, necessitating sandpapering. This again produces flat spots, which are indicated by the movement of brushes during operation. Flat spots promote sparking, and ultimately must be removed by turning. This is generally done while the armature is in the bearings, by the use of a turning tool. Unless the armature runs true in the bearings at no load, as well as at full load, the commutator cannot be made to run true. A brush that has once been overheated to the point of softening and crumbling is useless and should be replaced. Brushes should be so placed on the supporting arms that those on succeeding arms are staggered to prevent wearing grooves in the commutator. Generators work best with the brushes set a little ahead of the neutral point. In large generators the armatures are generally mounted directly on the engine shaft, and therefore, either the settling of the engine bearings or generator frame, or the wear in the bearings, may cause the armature to get out of its true position central to the bore of the pole-pieces. This eccentricity will promote sparking, and, if allowed to proceed too far, will cause very serious damage. It must be corrected at the start by lining up.

Satisfactory operation of generators involves as an essential condition the careful support and thorough insulation of all wiring connections, both on the machine itself and between the machine and switchboard, and also involves the good condition of rheostats, switches, instruments and circuit-breakers. In the case of alternators, special care must be given to the exciter and its accessories, as a failure at this point disables the generator. Finally, the most important consideration of all is to keep all parts thoroughly clean. Compressed air (free from water) should be used to blow out the inaccessible places at least once each week.

Motors.—The most important requirement for the satisfactory operation of motors, after cleanliness, is the proper care of the commutator. This part should be perfectly smooth and should show a hard, dark, glossy finish when running. When installing a motor or changing an armature the following conditions should be observed before starting up:

---

* This is a reprint of a little pamphlet prepared by Mr. E. B. Clark for the information of employes of the electrical departments of the Illinois Steel Company. Mr. Clark, who is assistant general superintendent of the works at South Chicago, is an electrical engineer. The pamphlet was prepared for the use of practical men, and difficult terms have been avoided. Believing that it will be of value to other practical men than those employed by the Illinois Steel Company, the *Western Electrician* sought and obtained permission to republish it.

(a) The armature shaft must be perfectly straight with smooth bearings.
(b) The commutator must be smooth and must run true with the shaft.
(c) The commutator must be free from short-circuits which may have been left by recently turning in lathe.
(d) The bearings must fit snugly to prevent lateral play of the armature.
(e) The brushes must be properly adjusted to prevent sparking.
(f) The armature should have a slight amount of end play.
(g) The motor gears, or the pulley and belt, must not cause serious vibration to the armature.
(h) The armature must be well balanced.

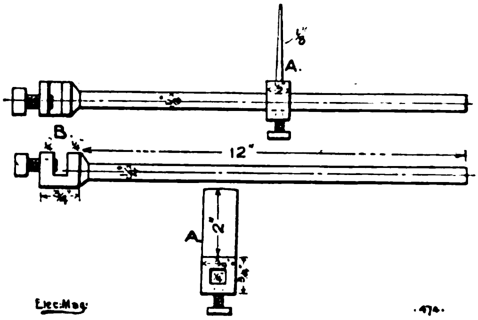
If these conditions are faithfully observed and the commutator kept clean, no trouble will arise, except, perhaps, from overloading the motor.

If, however, for any cause, the commutator shows signs of becoming rough, immediate steps must be taken to keep it smooth by the use of sandpaper or grindstone. Do not use emery cloth on a commutator. If the commutator gets "out of round," due to too much sandpapering, it must be turned in a lathe. Roughness causes sparking, and sparking increases roughness. Eventually the insulation between bars deteriorates and causes short-circuits. Such deterioration may be checked at the start, but must be watched very carefully, and, if it grows worse, must be attended to in the repair shop. In the case of motors with self-oiling bearings, care must be taken to see that the oil rings run freely and efficiently, and that the bearings are filled with clean dynamo or engine oil. The oil should be drained out and the bearing refilled with new or filtered oil occasionally. The frequency of this operation depends upon the condition of the oil in the bearing. In general, it should be done at least once a month, and more often if the oil becomes dirty. To prevent dirt from getting in the bearings keep all oil covers in place, and use felt dust guards where necessary, as in a cement mill. Where grease bearings are used, keep them well filled with clean grease of a stiffness depending upon the season. Where feed wires are used, or where felt wipers are used, these adjuncts must perform their functions satisfactorily. As bearings become worn and allow lateral or vertical play of the shaft, they must be replaced or relined. The amount of wear allowable depends upon the clearance from the armature surface to the pole faces. The armature must not strike the poles. It is needless to say that armature journals must be smooth to prevent cutting.

The wiring around the frame and between the fields of a motor should be kept in good condition, which means that it should be supported neatly and thoroughly and that the insulation should be good. The auxiliary apparatus, such as controllers, starting and field rheostats, switches, circuit-breakers, fuses and instruments, must be kept up in good shape to insure satisfactory motor operation. The danger of fire, always present where a motor is operating, is minimised if inflammable substances are kept away from the motor. Allow no rubbish to collect near it. Protect all exposed woodwork with asbestos. Avoid the use of wood in the construction of switchboards and other auxiliary apparatus. Finally, it should be remembered that the most important consideration of all is cleanliness. Keep oil and water from leaking on or around a motor. Use compressed air to "blow out" armatures and fields. If dirt collects in air passages and cakes, as it is apt to in cement mills, the motor will lose its ventilation and will overheat. Therefore, keep the dirt out.

A Commutator Tip.

Having to do a good deal of commutator work, I have often to cut 400 or 500 spokes. I have to use a pair of shears and have tried various ways so as to get the spokes all one length. The following, however, is, I think, the handiest method that I have adopted. Having previously gripped the shears in the vice and driven a file into the bench for distance, etc., I hit on the idea of fixing a gauge to the shears themselves. It will readily be seen that by gripping the gauge on to the bottom blade of the shears at B, strips can be accurately cut any length to 12 inches by moving the stop A.



A Commutator Tip.

Specialising.

One of the peculiarities of English workshops is the lack of specialising. Most men engaged in electrical workshops are to some extent all round men, and no doubt are capable of turning out very good work in any branch with which they may be acquainted. To enter into present day competition with foreign manufacturers of electrical goods, it is most essential that the rate of production should be the greatest possible. This cannot be secured by the all round man. Speed is always the outcome of constant practice, and to obtain the best results this must be centred on one particular object. In most American shops each man is restricted, not only to one particular class of work, but to one particular size. As a natural consequence, he becomes an expert and can produce work at top speed.

ELECTRICAL TRADE and COMMERCE

From every available source, both at home and abroad, special correspondents, consular and trade reports, and private sources, information will be published under this section in regard to new openings for the British electrical industry, progress of foreign firms in the world's markets, where contracts are pending or have been given out, and—in the case of the latter—if a foreign firm has been selected in preference to a British, it will be the endeavour of the Associate Editor responsible for this section to show why we were unable to secure the business. No effort will be spared in this connection to assist the British electrical trade, but strict impartiality will be preserved in every particular and foreign firms will secure their due meed of recognition.

* * *

The German Electrical Industry.

By the ASSOCIATE EDITOR.

In addition to various schemes for amalgamation, which have already been noticed in our previous issues, German manufacturers of electrical machinery and accessories have been steadily engaged in the consolidation of their respective undertakings, and, as evidenced by statistics now available, with a very fair amount of success. One of the most satisfactory features is that the company promotions during last year represent a total capital of only about £300,000, as compared with nearly £700,000 in 1902, and with £4,800,000 in 1897. The acute financial crisis which followed a period of reckless company floating has evidently taught its lesson, and those who have weathered the storm now appear to be striving for prosperity by the more sober methods which have always found favour in this country. Among the German firms who have been able to show satisfactory increases of profit during 1903 several may be mentioned:—The Bergman Electricity Works Co., of Berlin, having largely increased their output as a consequence of the extension of their works, have been able to pay 17 per cent. dividend on a capital of £425,000, this dividend being the same as that declared in the two preceding years. The Hartmann & Braun Co., of Frankfort, have also experienced an increase of sales, with the result that the net profit has increased from £9,456 in 1902 to £15,611 in 1903. Messrs. Max Schorch & Co., of Rheydt, although complaining very much of severe competition, have been able to pay 5 per cent. as against 4 per cent. in the previous year on a capital of £62,500, and, further, as orders continue to come in freely, the directors have decided upon the purchase and erection of additional plant.

The Electricity Supply Co., of Berlin, have been able to increase their dividend from 7½ to 8 per cent., and the Berlin-Hagan Accumulator Works Co. from 10 per cent. to 12½ per cent. Cable making firms also appear to have made satisfactory progress. For instance, the Land and Marine Cable Works, of Cologne, in spite of the fact that some important customers have been lost, owing to recent amalgamations, have had a record year in the matter of sales, and increased their net profit from £1,000 in 1902 to £16,405 in 1903. It is further stated that the prospects for the present year are exceedingly hopeful.

The South German Cable Works, of Mannheim, having completed the thorough re-organisation of their works, show a net profit of £11,511, as compared with only £539 in 1902. The Duisburg Cable Works Co. have made a net profit of £8,791 as against £3,747 in 1902, but complain of great depression in prices during the present year. The Insulated Wire Works Co., of Berlin, have been able to declare a dividend of 6 per cent. as compared with 2 per cent. in 1902.

It must not be supposed that prosperity is universal, for several well-known firms have to record continued losses or very small increases of profit. Nevertheless, it is clear that the electrical industry in Germany is now being conducted on lines that are calculated to lead to success.

British manufacturers will have reason for congratulation if this condition proves permanent, for there is nothing more detrimental to their own commerce than reckless over-production on the part of Continental competitors, which leads directly to the undue flooding of British markets with surplus products at ruinous rates.

GENERAL TRADE NOTES.

Electric Tramways at Leicester.

On May 18th the new electric tramways, which supersede the old horse tramways, were formally opened for public use. The scheme sanctioned by Parliament comprises 20 miles of double track and 3½ miles of single track. In April last the length of single track completed amounted to 33 miles, and the remaining 10 miles are nearing completion.

Absorption of the Union Company by the Allgemeine Company.

We now learn that the Allgemeine Company is increasing its share capital to £4,500,000, chiefly for the purpose of entirely absorbing the Union Company. Ninety-five per cent. of the shares of the latter company have already been acquired, and an exchange of the balance for new shares in the Allgemeine Company is about to be effected, when the absorption will be finally completed.

Melbourne Tramways.

At the beginning of 1903 it was proposed to construct a system of electric tramways to serve the districts of Essendon and Flemington, two suburbs of Melbourne, Victoria, and, more particularly, the race course at Flemington. The proposal was laid before the Councils of the districts, who agreed to it subject to certain conditions. Some difficulty was experienced, however, in obtaining the consent of the State Government, who raised an objection on the ground that the tram service would have an injurious effect upon the State-owned railways. Finally, the Government reconsidered the matter, and the scheme is now to be realised.

Electrical Engineering Industry in Germany.

It is interesting to note that 69,000 workers are employed in the electrical engineering industry in Germany. Out of this total as many as 24,000 are employed by the Allgemeine Union and the Siemens-Schukert Works Companies alone, while the balance is distributed among the 200 other manufactories in the country. When the large firms of Germany have finished the work of reorganisation, to which reference has previously been made in our columns, they expect to be able to pay greater attention to the question of prices, which for some time have been considerably depressed.

Electrical Trade in Australia.

We hear that the operation of the electricity works of the Sydney City Council will be commenced this month. The Council will supply, within the city boundaries, continuous current at 480 volts by a three-wire system; and, outside the boundaries, continuous current at 240 volts, and both single-phase and three-phase alternating currents at 415 volts. The equipment of the mains has been carried out by Henley's Telegraphic Works Co., and the sub-station plants were supplied by Messrs. Dick, Kerr & Co. The recommendation has been made that the latter firm should be selected for the supply of two additional 600 kw. three-phase generating sets for the power house, but no decision has yet been made with regard to this matter. Electric power and light power is now being installed at the mines of the Jumbunna Coal Co. The plant consists of a 160 h.p. three-phase generator, direct coupled to a Belliss compound engine, and will supply power for winding machinery, pumps, and other appliances, in addition to the supply of current for lighting the underground workings and various buildings in connection with the mines. The contract for the plant is in the hands of Messrs. G. Weymouth Prop, Ltd., who are manufacturing the electrical portion of the machinery in Melbourne.

Tramway Contracts in New Zealand.

The Christchurch tramway contract, amounting to £500,000, has been given to a local syndicate; but we are sorry to notice the statement to the effect that orders for the bulk of the machinery and material are likely to be placed in the United States. It is announced that the supervision of the works will be placed in the hands of Mr. F. Hubert Chamberlain, who was formerly connected with the General Electric Co. (U.S.A.). Acting upon the recommendation of Mr. W. R. Wright, city electrical and tramways engineer, the City Council of Wellington have decided to extend their system to Brooklyn, Island Bay, and Kilbirnie, at a cost of £68,611.

A New Belgian Tramway Company.

Arrangements are now being concluded for the conversion of the Rotterdam Tramway Maatschappij into a Belgian company, the headquarters of which will be at Brussels, and for which a concession has been obtained for 21 years, together with powers for the construction of a further length of seven miles of tramway in addition to the total mileage of 19 miles already in operation. The proposal is also under consideration for the adoption of electric traction on the whole of the system. The share capital of the new company will be £360,000, as compared with £251,000, the loan and share capital of the present company.

Electrical Industry in Germany.

We learn from a recent consular report that an incandescent lamp syndicate has been formed in Germany under the name of "Verkaufsstelle der Vereinigten Glühlampenfabriken G.m. b.H.," having its head office at Berlin. This syndicate embraces the German, Austrian, Hungarian, Swiss, and Dutch works; that is to say, the bulk of the Continental export manufacturers, and its objective is the raising of prices, which have become unremunerative. Each factory is to produce the class of lamp in which it excels. The highest quota in the company is held by the Allgemeine Elektricitäts Gesellschaft, Berlin, while Siemens and Halske, Berlin, and the "Vereinigte Elektricitäts Gesellschaft," Vienna, occupy the second and third places; all sales are effected through the head office of the syndicate at Berlin. The fusions effected in the electrical industry had no doubt a large share in the recovery of this industry. The demand has increased, and prices have gradually advanced. New hands were engaged, and overtime became pretty frequent in several works.

The near future offers little prospect for the installation of new central stations, and the demand for electric trams is very small indeed, as the larger towns have been already provided, and electric traction only pays in towns of more than 40,000 inhabitants. There are at present only nine towns of this size in Germany without electric street railways. Unless considerable saving can be effected in the working of electric trams, only about 150 miles could be laid and worked at a profit during the next 10 years; that is to say, about half the mileage operated by the one electric tramway company in Berlin.

Opening for Trade in Siam

We are pleased to learn from a report of the Austro-Hungarian Consul at Bangkok that there is an opening for electrical apparatus in Siam; and that there is also a special demand for artistic electric lamps. It is stated that the Siam Electricity Company and the railway companies are the principal buyers of electrical goods, the value of which, imported into Siam during 1902, was as follows:—Germany, £3,742; United Kingdom, £3,207; North America, £2,334; Other countries, £133; via Singapore, £568; making in all a total of £9,984

CONTRACTS CLOSED.

Power.

Coventry Town Council: 600 kw. alternator, Siemens Bros Ltd.; triple expansion engine, J. & H. McLaren.

Poplar Borough Council: Electric motors for 400 to 500 volts, £509, Alfred Williams & Co.; supply, erection and maintenance of storage battery, £1,860, Electric Power Storage Co.

Stoke-on-Trent Town Council: Motors, General Electric Co.

Winchester Corporation: Erection of a combined refuse destructor and power plant, Manlove, Alliott & Co., Ltd.

Partick Electricity Committee (through Bruce, Peebles & Co.): 780-864 h.p. engine for direct coupling to 500-kw. generator. Belliss & Morcom.

Great Western Railway Co.: Variable speed motors, Lister Electrical Manufacturing Co.

Manchester Electricity Committee: 7 motor generators, General Electric Co.; 2 750 kw. generating sets, C. A. Parsons & Co.

D. Selby Bigge & Co.: 25 electric motors, British Electric Plant Co.

Birtley Iron Co.: 400 kw. generating set, Brush Electrical Engineering Co., Ltd.

Liverpool Corporation: Sub-station at Walton, £3,000; Morrison & Son.

The Admiralty: 24 dynamos for battleships and 12 motors for use in firing torpedos, Laurence Scott & Co.; electric plant, including machinery for about 4,600 h.p., together with switchboards, etc., for Devonport Dockyard, Crompton & Co., Ltd,

Kilmarnock: Feed pumps, economiser, condenser and other auxiliary plant for the electricity works, Aiton & Co.

Wolverhampton Town Council: Steam generating sets for installation at the refuse destructor, £1,910; Thomas Parker, Ltd.

Launceston City Council: 500 electricity meters, £1,218; Ferranti, Ltd. (F. Barnes Spencer).

Ayr Town Council: Steam balancer and booster, £1,700; Siemens Bros. & Co.

Croydon Town Council: Furnaces, boiler, engine, generator and forced draught at the refuse destructor, £5,886 14s., Goddard, Massey & Warner.

Acton District Council: Motor transformers, booster and balancer, £3,425, Lancashire Dynamo Co.; switchboard, £1,140, Cowans, Ltd.; accumulators, £2,016, Electric Power Storage Co.

Lighting and Heating.

Grimsby: 530 lamps for schools, District Electric Co.

Ipswich Town Council: 5,000 yds. of lighting main and 200 yds. of cable for services, £895 5s, Johnson and Phillips, Ltd.

Bolton Corporation Electricity Committee: Cables, British Insulated & Helsby Cables Co.; casings, etc., Mr. R W. Kenyon.

London Metropolitan Asylums Board: Wiring the Eastern Hospital and Ambulance Station, £3,378 15s. 6d.; Bergtheil & Young.

Cambuslang: Electric lighting cables, £8,272; Johnson, Park & Co.

Kildare Rural District Council: Electric light generating stations, mains, etc., National Electric Construction Co., Ltd.

Swindon Corporation: 12 months' supply of cables, W. T. Glover & Co.; 12 months' supply of glow lamps, Edwards, Bays & Kye.

Shoreditch Borough Council: House service cables, Johnson & Phillips, Ltd.

Belfast Corporation: Electric light wiring at City Hall, W. Coates & Son.

Harrismith Municipality: High-tension concentric feeder and other cables, British Insulated and Helsby Cables, Ltd

Dublin Lighting Committee: Electrical plant, £19,227; General Electric Co.

Stockport Town Council: Nernst lamps, S. Fiddes & Co.; house cables, St. Helens Cable Co., Ltd.

Acton District Council: Cables, lamps, lamp-posts, St. Helens Cable Co., Ltd.

Deptford Council: Alteration of battery and new cells for the electric lighting of the town hall, Hart Accumulator Co.

Traction and Transport.

Lancaster Town Council: Construction and equipment of the tramway to the Castle station and the doubling of the South Road track, Robert W. Blackwell & Co.

Glasgow Town Council: Extension of the tramway system in Clydebank, A Stark & Son.

Swindon Corporation: Wiring of Swindon Car Depôt, Steel Bros.

Middlesex County Council; Light railway from Manor House, London, to the Alexandra Palace gates, J. G. White & Co.

Christchurch Tramway Board: Electric tramways, £249,876; New Zealand Electric Construction Co.

Epsom Council: Feeder and other cables, distributors, and pilot wire, £1,455 16s. 8d.; Western Electric Co.

HOME TRADE NOTES.

Printers' Exhibition. J. H. Holmes & Co., whose printing motors we described last month, were awarded a bronze medal and first-class certificate at the recent International Printing Trades' Exhibition.

Exhibition Award. Electro-motors, Ltd., Openshaw, Manchester, were awarded a silver medal and first-class certificate at the recent Printing Trades' Exhibition held at the Agricultural Hall.

The British Westinghouse Co., Ltd. Three-phase generating plant, of an aggregate capacity of 3,000 kw., Birmingham Corporation; 60 kw. motor generator and switchgear, Swindon Corporation; Transformers, Harrismith Municipality.

Messrs. Bruce, Peebles & Co. Engine and dynamo, Lincoln City Council; 500 kw. Peebles traction set, and extensions of the main switchboard, Partick Electricity Committee; 5,000 kw. in motor generators, Great Western Railway Co.

The British Thomson-Houston Co., Ltd. Electric installation in connection with the electric transmission scheme, at £7,977, the Birmingham, Tame, and Rea District Drainage Board; 750 kw. Curtis turbine, Fulham Borough Council.

Messrs. Dick, Kerr & Co. 5 600 kw. steam dynamos, 1 300 kw. set, 4 motor generator sets, 2 balancer sets, 1 main switchboard, switchboard and auxiliary plant for Portsmouth Dockyard, the Admiralty; 5 double-deck bogie tramcars, and 1 electric watering cart, at £4,290, Reading Town Council; 500 kw. traction set, £2,971.

Record Roofing. Messrs. Graham, Morton & Co., Ltd., Leeds, have recently done some record roofing work. The new Central Station, Leeds, has recently been roofed over in the space of one month from receipt of order. The area covered is 31,000 sq. ft. The order was placed on May 20th, and the work was completed on June 20th, the iron and steel work being finished on June 12th. Builders of electricity works should note these figures.

Messrs. Mather & Platt, Ltd. 500 kw. generators (repeat order) Colchester extensions; 175 kw. generators, 14 motors varying between 5 to 70 h.p. (repeat order) extension of large paper factory. Complete contracts from the Admiralty for dockyard, Simon's Bay, Cape Colony. 2—200 kw. dynamos and switchboard, storage battery 500 a.h. capacity, Booster, two portable motor generators, large number of motors from 5 to 50 b.h.p. Contract also includes boilers, engines, condensing plant, and overhead crane.

ELECTRIC FINANCE and Legislation

This section will deal in concise articles with the financial aspect of the various electrical undertakings, both in this country and abroad. Public Companies and Municipal Trading will come in for the closest attention and criticism. The articles will be published without fear or favour, and will deal impartially with the merits of each case and any principle involved. The obviously unfair treatment meted out to our manufacturers by some Municipal Authorities will receive special attention. Any unfairness will be exposed, and public attention will be roused where necessary.

The cost of the production of electricity, and the prices charged to the public, as well as questions of the incidence of various methods of charge, will also be dealt with. In this connection the accounts forwarded by Electric Power Companies and Municipalities will be critically examined and analysed.

British electrical enactments, some of which have paralysed the progress of the electric lighting business of this country, and set back the industry over a decade, to say nothing of other branches of electricity, require a vigilant censorship. The gentleman responsible for this section (who prefers to remain anonymous) has made the subject of Electrical Legislation a speciality, and speaks with weight and authority. The expositions and matter he will contribute, therefore, should have a value beyond the pages of the Magazine.

The Electricity Supply Bill.

In the first issue of *The Electrical Magazine* this section contained a summary of the electrical legislation of 1903, and on that occasion reference was made to the Bill introduced by Lord Wolverton, in the House of Lords, to amend the acts relating to electric lighting. Unfortunately the Bill was introduced too late in the Session to allow of substantial progress being made; but accepting the mere fact of its introduction as a sign that the Board of Trade was willing at last to do something to remove some at least of the many objections to the present laws, we expressed the hope that no time would be lost this Session in re-introducing the Bill, and that it might be placed on the statute book at the earliest possible date. We are, therefore, exceedingly glad to note that Lord Wolverton has again brought forward his measure, altered in form in some respects from that of last year but in all material points containing the same substance. It does not provide for a complete revision of the existing law relating to electric lighting, and on this ground there may be many who will find fault with the Bill; but as its clauses, if passed into law, will give valuable amendments on many important points, and as these amendments are on the lines recommended by Lord Cross's Committee of 1898, we are disposed to give the scheme a hearty welcome for what it contains, rather than criticise it for what it does not contain. The matter is of such great moment to the electrical industry that we make no excuse for dealing at some length here with the text of the Bill.

Sites for Generating Stations.

It has always been a matter of complaint that the Electric Lighting Acts do not provide for the acquisition of land for generating stations outside the area for the supply of which that station is to be used, and further, that even within the area of supply such lands can only be acquired by agreement. The objections to such a state of affairs are obvious. When the undertakers are limited to sites which they can only obtain by private agreement with owners, they often find it impossible to get the particular lands which are in the best position, either geographically or for most economical distribution, and they have therefore to be content with inferior sites. But further, in the case of cities and towns of good size, land is very dear, and it would often be much more economical to erect the generating station at some distance from the town and lay transmission lines to the area of supply. This, however, cannot be done where the authority to supply electricity is given by Provisional Order; and therefore, it becomes necessary to go to the expense of promoting a private Act to obtain the necessary powers. By clause 1 of the new Bill these two defects are removed. It is provided that the Board of Trade may by Provisional Order grant power to acquire land compulsorily whether situated within or without the area of supply, and the provisions of the Lands Clauses Acts, relating to the purchase and taking of lands, otherwise than by agreement, are to be incorporated with the Electric Lighting Acts. We cannot see any reasonable ground of objection to these amendments, and the clause ought to pass without opposition. Clause 2 is auxiliary to clause 1, and gives the necessary authority to the Board of Trade to grant powers by Provisional Order for the breaking up of streets, &c., for the laying of cables from a generating station outside the area of supply to the boundaries of that area, just as if these streets were within the area.

Supply in Bulk.

Power supply companies have at present to promote a private Act in Parliament when they wish to be authorised to supply electricity in bulk to authorities or companies for distribution in their areas; but clause 3 now brings this within the scope of a Provisional Order. This is as it should be, for the practice with regard to Power Bills is now fairly well settled, and there is no reason why the expense of promoting a private Act should be incurred. In entrusting the matter for the future to the Board of Trade, there is also the further advantage—a very important one—that absolute uniformity of practice will be obtained, and a permanent and technical tribunal will take the place of Committees, chosen in an arbitrary fashion, whose members are at times not free from prejudice. There is one sub-section of this clause which may become of great value by reason of the elasticity of its terms. Sub-section (*d*) provides that the Board of Trade may by Provisional Order: "make such other provisions as appear to them necessary for adapting the Electric Lighting Acts to any case where a company or person are authorised to supply electricity in bulk in any area." Thus, if it should happen that such a company desired certain powers, and a doubt should arise whether the grant of these powers by Provisional Order is or is not within the scope of the Electric Lighting Acts, this section will get over the difficulty by enabling the Board of Trade to "adapt" the Electric Lighting Acts to meet the case.

Right of Local Authorities to Purchase Undertakings.

As power supply companies have wide areas, covering usually the areas of many distinct local authorities, it is obviously undesirable that their schemes should ultimately be split up into many separate little schemes by the purchase, by each local authority, of that part which lies in its area, and clause 4 is intended to provide for such a case. It gives the Board of Trade power to exclude the application of section 2 of the Act of 1888 (which gives local authorities this right of purchase), wherever they consider such right is inapplicable, "either by reason of the undertaking being situate in a number of districts, or by reason of the undertaking not being such as can be properly carried out by local authorities, or by reason of any other special circumstances affecting the undertaking." But before deciding on the matter the Board of Trade must give notice to the local authorities who would otherwise have the right of purchase, and must hear their objections. This is a very fair clause, as it protects the interests of all parties and allows of the best arrangement in the public interest being made. Local authorities need have no fear that their interests will not be looked after, as the Board of Trade has always in the past listened favourably to their applications—some would say too favourably. Clause 4 also provides for a local authority, which has power to purchase so much of the undertaking of a company as is within its area, transferring that power, with the consent of the Board of Trade *and with the consent of the company*, to any other local authority having power to purchase so much of the *same* undertaking as is within *its* area. Clause 5 provides for the management of undertakings supplying the districts of more than one local authority, by a joint committee, or joint-board, or otherwise.

Exit the Veto.

Clause 6 will be welcomed more than any other by the members of the electrical industry. It repeals that part of Section 1 of the Act of 1888, which gives local authorities a veto on schemes for electricity supply, and declares in express terms that the Board of Trade, when considering whether any Provisional Order should, or should not, be granted, "shall take into consideration the views of the local authorities affected on the subject, but whether the consent of any local authority is, or is not, given, may grant the Order, or not at their discretion." Let us hope that whatever opposition may be brought against this change, we may see this clause passed into law before the end of the Session.

Sundry Provisions.

The remaining clauses of the Bill contain several points of interest, but they must be dismissed here with brief notice. Clause 7 makes five years the period for revision of maximum price, instead of seven years as at present, and it also allows application for revision to be made, not only by the undertakers, or the local authority, but also by "such number of consumers, not less than twenty, as the Board of Trade consider sufficient, having regard to the population of the area of supply." Clause 8 makes some slight alterations in the provisions regarding certification of meters, and clause 9 alters the date for the making up of the electrical accounts of local authorities to bring it in line with the date in force for their other accounts. Clause 10 makes a term of the general statute law a provision which is often inserted in private Acts, exempting undertakers from liability to supply premises which have already a separate supply, unless the person demanding such supply agrees with the undertakers to pay such an annual sum as will give them a reasonable return on the capital expenditure incurred; in default of agreement, this sum to be paid is to be fixed by arbitration. Section 11 deals with contracts between local authorities, being authorised to supply electricity, and companies or persons, also so authorised. The final clauses contain definitions and descriptions.

Summary.

The whole Bill appears an earnest attempt on the part of the Board of Trade to remedy some of the outstanding defects in the law relating to electric lighting. We believe the Board is really desirous of placing this measure upon the statute book, and we therefore feel confident that a serious effort will be made to push it through the various stages. But much can be done by the members of the industry to secure this end, and we hope that everyone will keep a watchful eye on the progress of this Bill and will cry out at once if there should be any slackness on the part of those responsible for its introduction. The Government can facilitate or retard its progress; it is for us to see that the former course is adopted.

THE NEW LIGHT RAILWAYS BILL.

We do not know whether it is altogether matter for congratulation that, at the same time as the Electricity Supply Bill is introduced into Parliament, there should also appear a new Light Railways Bill, and there are two reasons for this attitude. In the first place, it is quite certain that there will be little enough time for the discussion of electrical legislation, and we would rather see that time given wholly to one measure to ensure its passing into law, than divided between two, with the probable result that neither may reach the statute book. The Board of Trade may say that both measures have been promised, and therefore both must be introduced; but the electrical industry will not be content with the *introduction* of reformatory measures, and the official promises will not be considered as fulfilled until the actual reforms have been made. To us it certainly appears that the best course to adopt would be to take the measures one at a time, and work untiringly on the first till it is finished before dealing with the second. To take the two together is to imperil the chances of both.

The Traffic Commission Report.

But there is a second reason for delaying the new Light Railways Bill. Its provisions do not touch upon the real reforms required, but only "tinker" at one or two clauses in the old Act. It is possible that this is due to the fact that the London Traffic Commission is soon to make its report, and that, although the Light Railways Act applies to the whole country while the Commission only deals with the metropolis, yet it is felt to be desirable to await the plan of procedure developed for London before drafting an entirely new Act for the country at large. The final meeting of the Commission took place on June 2nd, and ere long we shall have its report. If, then, we are to have a new Light Railways Act after the publication of that report, it would be much better to wait a year for the complete reforms rather than seek now to modify a few points in the old Act, which is so soon to be superseded. On this ground, therefore, the present Bill is merely a waste of time. On the other hand, if we are not to have a new Act introducing thorough reforms, we will certainly not be content with petty reforms like those in the present Bill, and no thanks will be given for such a measure. In either view, then, we are not inclined to welcome the appearance of this Bill at the present time; but let us see what its proposals are.

A Scheme to Save Time.

There is practically only one point in the Bill. As is well known, the powers of the Light Railway Commissioners are strictly limited, and where a scheme brought before them is shown to be for an undertaking which, if constructed, would compete with existing railways, they must decline to proceed with the hearing and must require the promoters to seek powers direct from Parliament. That means that a private bill must be prepared and deposited, and consequently there is a delay of a year, and also a fresh expenditure of money. The new Light Railways Bill proposes to avoid this delay and expense by authorising the Board of Trade in such a case to embody the scheme in a provisional order, which may go at once to Parliament for confirmation in the ordinary way. If opposed, it will be considered by a select committee of each House, or by a joint-committee of the two Houses.

A Promise Unfulfilled.

This, then, is the long promised reform of the Light Railways Act—"only this and nothing more"! In itself, the change proposed is an improvement on the old procedure, and as one item in a thorough scheme of reform it would be welcome. But it is surely ridiculous to put this forward alone, and to treat such a measure as an amending Act. Had no promises been made the case might have been different; but two years ago the President of the Board of Trade told the deputation from the Institution of Electrical Engineers, that a Bill had been drafted which he thought would go very far to meet their objections. What has come of that Bill? Mr. Gerald Balfour cannot have been referring then to this Bill now brought forward.

THE NORTH WALES POWER BILL.

Transmission by Overhead Wires.

The successful passage of the North Wales Electric Power Bill through the committee stage in the House of Lords would in any case have been a matter for congratulation, as the scheme ought to be of great advantage to the communities in the areas involved, but it is especially noteworthy in that the Bill provides for the transmission of power by overhead wires. This provision is not in itself new, as it has been allowed in other schemes, but in the case of North Wales a step further has been made. The company, by this Bill, takes power to erect overhead wires, subject to the consent of the Borough, Urban District, or Rural District Council, as the case may be, but this consent must not be unreasonably withheld, and an appeal is given to the Board of Trade. In no previous Bill have Urban District Councils been put on the same footing, in this respect, as Rural District Councils; their veto has not hitherto, like that of Rural District Councils, been made subject to being overruled by the Board of Trade; but here, in spite of opposition, all three classes of local authority have been treated alike. This is as it should be, for there is no reason at all why an absolute veto should be given to any local authority. Another interesting feature in this Bill is that water power will be largely used in the generation of electricity.

FINANCIAL NOTES.

A New Issue.

STILL another private firm engaged in the electrical industry is to join the ranks of the limited liability companies. Messrs. Johnson and Phillips are now floating their business as Johnson and Phillips, Ltd., with a capital of £400,000, half in ordinary shares and half in 6 per cent. cumulative preference shares, and in addition £100,000 of 4½ per cent debenture stock. We shall be interested to watch the progress of this issue.

A Successful Issue of Capital.

A month ago we drew attention in this section to the new issue of capital then being made by the Newcastle-upon-Tyne Electric Supply Company, and we then expressed the opinion that even with the premiums attached, the shares could hardly fail to be an attractive investment. We are glad to learn that the public has shared that opinion, and has welcomed the new issue. The applications for ordinary shares exceeded the number of shares—17,991—by 70 per cent, although a premium of £1 was attached to each £5 share. The preference shares, £5 each, with a premium of 10s. attached, were also over-subscribed. This is proof of the confidence with which the company is regarded by those who follow the progress of the industry, and we hope that its future rate of progress will be even greater than that which it has shown in recent years.

Electricity Supply in London.

AN interesting return, giving an analysis of the accounts for one year (1902 in the case of companies; 1902-03 in the case of local authorities), of all the statutory electricity supply undertakings in the county of London, has recently been prepared for the County Council by its statistical officer, Mr. Edgar Harper, and is now published. It affords material for comparisons of the financial positions and methods of management of different companies and local authorities, and enables us to learn at a glance what provision the municipal corporations are making for depreciation and similar charges. We have always known that insufficient allowances were made in this matter in municipal undertakings, but we confess it has been a surprise to us to learn how very little has really been done in London towards providing for worn-out machinery and plant. The majority of the Borough Councils supplying electricity have no depreciation fund at all, and many have, in addition, no reserve fund; so that it seems as if these bodies are still of the opinion that to make payments to a sinking fund for repayment of loans is the same as making provision for depreciation. This opinion was at one time more general among local authorities than it is now, but even now it is fairly prevalent, and some of the London Borough Councils seem to be among its strongest supporters. Their error will be discovered in time when they find their plant all worn out, their original loan not yet repaid, and themselves compelled to incur a fresh loan to obtain new plant. It is obviously most desirable that municipal electrical undertakings, being supported by public money, should be conducted on thoroughly sound financial lines; but scrutiny of these County Council statistics gives strength to the opinion that this is not being done. These returns deserve the attention of all who are interested in electricity supply, and they will be found instructive by all who have sufficient knowledge of such undertakings to know how to use these tables intelligently.

Fair Play!

WE have had occasion more than once to criticise the policy of the Glasgow Corporation in some of its trading enterprises, but we must on the present occasion congratulate that body on its rejection of a proposal recently brought forward by a few members, which aimed at taking an unfair advantage of the position of the Council to inflict injury on a trade rival. The proposal was that the municipal departments of the Corporation, other than the fire brigade and police offices, should take all their telephones from the Corporation alone. Had this been adopted, it would have meant that all the ratepayers who desire to communicate with Corporation departments, and who at present use the National Telephone Company's system, would have been compelled to reject these instruments and take in those of the Corporation; and indeed it was not denied by the supporters of the proposal that this was the object they had in view. One of these gentlemen openly declared that "war was necessary sometimes," and "that the National Company had in various ways attempted to injure the Corporation." It is to the credit of the Corporation, however, that the large majority of its members would not hear of such action on the part of the Council, nor would they allow the proposal to be withdrawn, but insisted on a vote being taken. When this was done, 47 members voted against it, and four for it, while eight declined to vote. To have adopted such a resolution would certainly have disgraced the Council in the eyes of fair-minded men, and it would have dealt a very heavy blow at the disinterestedness of municipal trading.

Leeds Electrical Undertakings.

THE accounts for the electricity undertakings of local authorities in England and Wales are, as a rule, closed at the 31st March in each year, and information regarding the financial position of these undertakings is now coming in. As usual, we find great differences—some quite successful, others quite the reverse, and others just managing to "pay their way." Of the first class, Leeds is a good example, and this year it shows good balances both on its tramways and on its electric lighting. From the tramways an increase in gross receipts over last year of over £15,000 has been recorded, and the gross profit has been increased by £12,000. After paying all charges, a balance of £52,000 is available for relief of the rates. Similarly, on the electric light undertaking, Leeds has increased its gross profit of last year by £12,876, and has handed over about £3,500 for the relief of rates.

Assessment of Electric Tramways.

An important case on the question of the assessment for rating purposes of electric tramways leased by a company from a municipal corporation was decided recently by the Divisional Court, consisting of the Lord Chief Justice, Mr. Justice Wills, and Mr. Justice Kennedy. The New St. Helens and District Tramway Company, Ltd., are lessees of tramways owned by the municipal corporation. The generating station, cables, posts and other equipment for supply are provided by the corporation, which also supplies power to a few other companies, and to its own pumping stations by means of the same equipment. The generating station is controlled by the corporation, and that body also repairs all the supply equipment. In this state of affairs the tramway company was rated at a gross estimated rental of £3,165, and a rateable value of £2,110 as "occupiers" of the station, posts, cables, and other parts of the system, and against this assessment appeal was made. It was contended by the company that they were not the "occupiers" of this equipment through which power is supplied to the cars, and that they were therefore not rateable in respect of this equipment, which should not have been taken into consideration by the rating authority in estimating the net annual value of their premises. After hearing both sides, the court unanimously held that the corporation, and not the company, were the occupiers of the posts, wires, cables and equipment, and therefore that the rate must be reduced accordingly. As a result the gross estimated rental is reduced to £1,500, and the net rateable value to £1,000. As there are other companies working under somewhat similar arrangements with other corporations, this decision is of considerable importance, as it means a great saving to the tramway company. We notice that leave to appeal was granted, and we shall be interested to note the result.

Manchester.

The Tramways Committee of Manchester has handed over a sum of £55,000 for the relief of the rates. The corporation is now seeking authority to borrow £135,000 additional capital for electricity supply, and an inquiry has recently been held. Of the total loan desired, £94,490 is for additional mains, and £10,000 for development of the city's motor-hiring scheme. Opposition to the loan was made by the Manchester, Salford, and District Property Owners' Association, on the ground that the indebtedness of the city already amounts to £21,000,000, and that there is a prospect of a heavy increase in the rates.

Tunbridge Wells.

The Town Council of Tunbridge Wells has decided not to accept the offer made by a London syndicate to take over its electricity supply undertaking at the price of £80,000, with a bonus of £10,000. This decision seems to have created a good deal of discontent in the locality, and the agitation for the sale of the undertaking does not seem to be, by any means, at an end. Probably we shall hear more of this later. At present the local press is kept busy printing letters from correspondents protesting that the undertaking is sure to come on the rates, and we shall not be surprised to find that prophecy come true.

Bristol.

In the matter of depreciation allowances, the Bristol Corporation sets a better example than that of Hull (see below). There we find that after paying interest and sinking fund charges, the Electricity Committee has a net profit on the year's working of £8,207 5s. 6d., and of this sum over £5,000 is paid to depreciation and contingency account, £2,000 to reserve fund, and the balance is carried forward. We have not been able to analyse the accounts to see on what basis these depreciation charges are calculated, but it is satisfactory to find the sound principle here adopted. We wish it were universally accepted by local authorities.

Brighton.

We recently commented on the proposal of the Brighton Corporation, to borrow fresh capital for its electricity department, to be used to meet the cost of changing the pressure of supply in a portion of the borough. We are glad to see that this proposal has been keenly opposed at the inquiry, and we hope the opposition may be successful. It seems clear to us that this charge should come out of revenue, and that it is bad finance to create fresh capital for such a purpose. Considerable feeling has been roused in Brighton by the judgment in the lawsuit brought by Messrs. Macartney, McElroy and Co., Ltd., against the Corporation, which resulted in a complete victory for the company. The learned judge appears to have "let himself go" in a somewhat remarkable manner, and while the case perhaps called for strong comment, we cannot but regret that the judge should have allowed himself to make personal remarks regarding the town clerk and others which were quite unnecessary and, to say the least, unfortunate.

Hull.

The report of the Hull Corporation Electric Lighting Committee shows a balance for the year on the right side, but on the whole the result is not so favourable as one would like to see. Of the net revenue of £18,226, no less than £16,587 is required for payment of interest, sinking fund and *meter* depreciation, and one is compelled at once to ask: why should depreciation charges only be allowed in the case of meters? It is clear that if depreciation charges were made on all the plant that deteriorates by use, there would be a debit balance instead of this credit balance of £1,639 carried to reserve fund; and it is for this reason the report does not appear quite satisfactory to us. We hope that in future years this fault will be repaired, and care taken to place the undertaking on the most sound financial basis. We are glad to learn that the Corporation has the prospect of a large addition to its power load. One firm which has applied recently for a supply of electricity, chiefly for motive power, will require over half a million units per annum, and the North Eastern Railway Company wishes a supply for its docks, sidings, and city station, which is estimated at 1½ million units per annum. For all this additional load further plant will be required, but if satisfactory arrangements are made with these consumers, the revenue derived from them, and the greater economy obtained in the working of the whole installation, should more than compensate for this expenditure.

New ELECTRICAL PATENTS

Claims of the principal British, American, and Continental electrical patents will be presented in this section in such a form as to be of the maximum value to those requiring to follow the inception of important new inventions in every branch of the electrical industry. It has been decided after careful deliberation to exclude illustrations or detailed descriptions of patents and specifications, as matter on this subject if presented in that form only partially indicates the nature of a particular patent. By an examination of the claims of the patentee a distinct clue to its value is afforded, and in many instances much time will be spared. The Associate Editor is an experienced patent agent, and he is prepared to supply, through the medium of this magazine, information in response to queries relating to patents, patent litigation and kindred subjects.

SELECTED SPECIFICATIONS.

By E. de PASS, F.Ch.Inst.P.A., 78 Fleet Street, E.C.

Magnetic Devices for Gripping and Releasing Bodies, for use with Cranes, Hoists, Winches.

August Reichwald, London (a communication from The Duisburger Maschinenbau Actien-Gesellschaft, late Bechem and Keetman, Germany). No. 3746. Dated 15th Feb., 1904.

Ordinary electro magnets have been employed in connection with the tackle of lifting machinery for the purpose of gripping iron bodies (or bodies which are capable of being so gripped) during transportation, but a disadvantage exists in the fact that, in the case of accidental breaking of the electric circuit, and the magnet so losing its attractive force, the object carried is at once dropped. The present invention has reference to safety mechanism acting mechanically to prevent the accidental dropping of the load entirely, even if the electric circuit be accidentally interrupted and the carrying magnet thereby demagnetised.

Claims.—(1) In magnetic devices for gripping, conveying and releasing bodies applicable for use with cranes, hoists, winches and the like; the safety mechanism comprising the vertical revoluble shafts with inwardly bent lower ends, and mechanism by which the said inwardly bent ends are mechanically caused to turn outwards from beneath and clear of the lifted body when the latter is to be set down, and to be turned inwards beneath the lifting body when the latter is raised in order to prevent dropping of the load by accidental interruption of the electric circuit of the lifting magnet.

(2) In magnetic devices for gripping, conveying and releasing bodies applicable for use with cranes, hoists, winches and the like; the combination therewith of vertical axially revoluble rods carried by a frame, the latter being free to move vertically and guided relatively to the load-lifting magnet, bent ends to the rods brought beneath the load by the partial revolution of the said rods when the load is raised, and mechanism for simultaneously revolving the rods to release or hold the weight lifted.

Electromagnetically Operated Apparatus for Controlling the Inlet Devices of Steam and Gas Turbines.

Theodor Reuter, Winterthur, Switzerland. No. 26144. Dated 30th November, 1903.

This invention relates to electromagnetically actuated apparatus for controlling the inlet valves or appliances of steam and gas turbines in which apparatus the closing of the several electric circuits is controlled by the governor, and is effected by means of a liquid switch or contact making device common to all the circuits, and so arranged that a greater or less number of contacts are immersed into the liquid according to the load on the turbine.

The said controlling apparatus is applicable both for single stage steam and gas turbines, and for multiple stage turbines, arranged in series.

In the latter case the controlling apparatus can be so arranged that each of the turbine stages receives a varying supply of motor fluid corresponding to the varying load on the machine in such manner that by the same liquid switch that controls the inlet devices of the first stage a number of the inlet devices of the following stages are opened, corresponding to the varying supply to the first one.

Claims.—(1) In an electromagnetically operated controlling apparatus for the inlet devices of steam and gas turbines, wherein the closing of the several electric circuits is regulated by a governor, the employment of a liquid contact switch into which a greater or less number of the closing contacts of the electric circuits are made to dip according to the load on the turbine.

(2) In an electromagnetically operated controlling apparatus, such as is referred to in the first claim, so arranging the liquid contact switch that it only controls the inlet devices of a single turbine stage.

(3) In an electromagnetically operated controlling apparatus, such as is referred to in the first claim, so arranging the liquid contact switch that it controls the inlet devices of several turbine stages.

Improvements in and relating to Brakes, particularly applicable to Brakes for Electric Tram Cars.

THOMAS VICKERS and ERNEST ANDREWS, both of Nottingham. No. 5204. Dated 5th March, 1903.

This invention relates to improvements in electric brakes of the kind used on electric tram cars, the said improvements being particularly applicable to tram cars fitted with safety appliances at the ends of the same ; the object of the invention being the provision of means whereby the magnetic brake is applied automatically whenever the safety gate or guard, or both, is or are moved from its or their normal position.

According to the invention, as applied to a tram car fitted with the usual controller and hand operated magnetic brake, the electric connections between the controller and motor are fitted with a switch so arranged that when the switch lever is in one position the current from the trolley wire passes to the motor, and when the switch lever is in another position the current from the motor, when acting as a generator, passes to the magnetic brake.

The switch lever is connected by levers and links, gearing or equivalent mechanism to the gate or guard of the safety appliance, and when this appliance is operated by any obstruction on the road, the magnetic brake is automatically applied. In one arrangement the switch is held in its motor driving position by a catch, from which it is liberated by an arm on the gate axle, and when so liberated is moved to the brake position by a spring. The switch may be positively operated in either or both directions from the gate or guard, or both the gate and guard may be coupled to the switch.

Claim.—The combination with a controller, motor, and magnetic brake, as used on electric tram cars, of an automatic switch arranged and operating for the purpose set forth.

Improvements in Electric Motors and Regulating Devices for Railway Trains or Vehicles Actuated by Electrical Energy.

John Smith Raworth, of Streatham Hill, Surrey. No. 5494. Dated 9th March, 1903.

This invention relates to improvements in the electrical control of trains consisting of a plurality of vehicles, of which more than one are fitted with motors. Some parts of the invention are applicable to single vehicles.

The object of the invention is to make the electro-motive force of the armature to some extent independent of the current and of the direction of the current in the armature, and for this purpose the motors have in the field winding a shunt winding. In its simplest form, the invention is carried into effect by providing the motors with a simple shunt winding of low resistance controlled by a rheostat by means of which the field may be varied from maximum to minimum at the will of the driver. In this form the invention is best suited to those cases in which a number of motor driven vehicles form one train and in which the stopping places are near together. In such cases, the shunt field must, in order to be sufficiently strong, be wasteful. Therefore, in order to minimise this waste it is desirable to divide the field winding into two portions, so that the serious expenditure of energy may only occur when absolutely necessary—that is to say, at starting and stopping. Or the field may be reinforced by means of a series winding so arranged as to be cut out or short circuited except when the motors are acting as generators or when the shunt field is very strong.

As to the method of control, it is necessary to note that this is entirely different from that employed with series wound motors. According to the present arrangement, when once the armatures are placed in circuit they must not be switched off again until it becomes necessary to bring the train or vehicle to a dead stop, variations in speed being effected by varying the strength of the fields alone until the slowest speed so obtainable is reached, when the current must be cut off and the brakes applied. In reducing speed, energy is returned to the line. As, therefore, the cutting off of the current and the putting on of the brakes are simultaneous operations, the armature switches on the vehicle or several vehicles may be operated by the brake gear. The shunt fields must in any case be controlled by a rheostat on the driving platform, and whenever it is possible that the number of vehicles may vary the shunt coils of one vehicle must be fed in parallel with those of the others.

If a series winding be employed it must be controlled either by an independent circuit passing through the controller, or by an automatic device depending firstly on the strength of the current in the shunt field circuit, and secondly on the direction of the current in the armature or on retardation of the moving mass, so that it may never be operative except at slow speed in retardation.

The brake handle on the driving platform is interlocked with the rheostatic regulator by means of a magnetic device so that the brake cannot be released until the current in the shunt field is at or near its maximum, but the brake is at all times free to be applied.

Claim.—For the electrical control of railway trains or vehicles actuated by electrical energy, the combination of electric motors of the kind specified with regulating and braking devices substantially as hereinbefore described.

Readers are referred to p. 600 of this issue for further details of Mr. Raworth's system.

REVIEWS of BOOKS

Under this heading will be presented concise reviews of all new books on electrical and cognate subjects, as published. The reviewers will necessarily be technical experts. The prices of books and names and addresses of publishers are given.

SHORT NOTICES.

Radium and All About it. By S. BOTTONE. Whittaker and Co., Paternoster Sq , E.C. 1s. nett. The title of this little book is very comprehensive, and to an expert scientist may seem presumptuous; still, as a popular account of the latest work of science, it is worth reading.

O'Gorman's Motor Pocket Book. By MERVYN O'GORMAN. Archibald Constable & Co., 2 Whitehall Gardens, S W. 7s 6d. nett. The chief item of interest to electrical men in this valuable little book is naturally the subject of ignition. Beyond this the bulk of the book is valuable only to motorists. In this respect, however, it should fill a decided want.

Whittaker's Electrical Engineer's Pocket Book. Edited by KENELM EDGCUMBE. Whittaker & Co., Paternoster Sq., E.C. 3s 6d. This pocket book is carefully sectionised for ready reference. In addition to a mass of useful data, many valuable references are given to recent papers and publications where full details of the subject can be found.

Synopsis of the Patent Laws of the World. J. P. O'DONNELL. Published by the author at Palace Chambers, Westminster, S W. Price 1s. nett. A useful work which should be in every inventor's and manufacturer's hands. There is a section relating to Patent Laws in Great Britain, the remainder of the book dealing with Foreign and Colonial Patents.

X Rays Simply Explained. By R. P. HOWGRAVE-Graham, Percival, Marshall & Co., 26-29 Poppins Court, Fleet Street, E C. 6d. nett. This forms a useful addition to the Model Engineer Series, of which it is No. 19 It explains the subject in question in considerable detail, and makes very good reading. The radiographs, of which there are five full page illustrations, are very clearly reproduced.

Oil Engines: Their Selection, Erection, and Correction. By W. A. TOOKEY. Merritt & Hatcher, Grocers' Hall Court, Poultry, E.C. 1s. This is a handy little book which should be in the possession of every oil engine engineer. There is a useful introductory on petroleum, some comparisons between oil, gas, and steam engines, and the powers of oil engines. The section on the correction of troubles is very complete.

Central Station List. Mar. McGraw Publishing Co., 114 Liberty Street, New York. Published quarterly; subscription \$4 per annum. In addition to the valuable list of Electric Light Central Stations, this issue gives particulars of the National Electric Light Association, Central Station Work in Germany, and Central Station Statistics. The whole forms a valuable work of reference, which has the advantage of being regularly brought up-to-date.

Modern Wiring: Diagrams and Descriptions. By H. C. HORSTMANN and L. H. TOUSLEY. F. J. Drake & Co., Chicago. Here is a little book which should be invaluable to every wireman or electrician. It would also be useful for central station men as, although it does not deal with "heavy" electrical engineering, its diagrams are not beneath the notice of central station engineers. There are nearly 200 diagrams in all, and the authors must be congratulated for the thorough manner in which they have completed their work.

Directory of Electric Lighting and Traction, 1904.

Edited by C. S. VESEY BROWN. Hazell, Watson, and Viney, Ltd., 52 Long Acre, W.C. Price 10s. 6d. nett.

Our notice of this valuable directory, now in its fourth edition, has, unfortunately, been crowded out of previous issues; still, we are not too late to commend it to our readers. As a statistical work of reference it should be in the office of every electrical engineer. Those possessing the earlier editions can make interesting comparisons in the results of undertakings for previous years. With the appendices and index to each section, the work is singularly complete.

20th Century Handbook for Engineers and Electricians.

C. F. SWINGLE, H. C. HORSTMANN and VICTOR H. TOUSLEY. F. J. Drake & Co., Chicago.

To engineers and electricians accustomed to Molesworth, the large type of this book will come as a relief. The first part of the book is purely engineering, and calls for little comment, except perhaps that steam turbines are religiously omitted. The second half, by the two last engineers mentioned above, contains some 15 chapters on electricity for engineers. Written in a style admitting of little misconception, the data presented should help any engineer with a grain of "common" to grasp the principles and a few of the practical applications of electricity. Some engineers are so profoundly ignorant on these points that they need some enlightenment. Let them seek it in these pages, when their quest will be materially assisted by the questions concluding each chapter. What at first appeared the enunciation of some new theory in the word "Engioperation," at the head of a page proved to our relief to be the printer's substitution for "Engine Operation." The book is strongly bound in a substantial cover with a snap flap.

Electrical Engineering.

By E. ROSENBERG, translated by W. W. Haldane Gee & Carl Kingbrunner. Harper & Brothers, 45, Albemarle Street, W. Price 6s.

From the preface we gather that this work embodies matter presented at lectures to the workmen and staff of a large electrical manufacturing firm, and that it makes no pretence at being a mathematical treatise on the subject with which it deals. It is for the elementary student, the wireman, the engineer, and also for the general public, and upon this basis we can commend it heartily. That it has been translated—and that admirably—from the German is sufficient evidence of its scope and worth. From the fundamental principles, magnets and magnetic lines of force, the reader is led up to the continuous current dynamo and motor, all of which are clearly explained. Accumulators and electric lighting come in for ample treatment, while the section on alternating currents is very explicit and should be easily followed. To elementary students and workmen we would recommend this section. The last chapter deals with high tension work, and is purely general in tone. On page 261, an illustration of the old Brush trigger switch is shown upside down. Are we to infer that the author's non-acquaintance with this switch is responsible for an error, which, if practically carried out, would result in the speedy disappearance of the switch when opened under load? To so old and faithful a servant this is hardly justice, for what would our old single-phase stations have done without their cord switches? In this case, as in others, the illustrations are somewhat out of date, but as the issue before us is dated 1903 we cannot be too exacting. In any case the chief features of the book are in no way influenced by this circumstance.

Handy Electrical Dictionary.

Compiled and Edited by W. L. Weber. F. J. Drake & Co., Chicago. Price 1s. 9d. nett (leather).

(This book can be supplied from these offices on receipt of published price.)

Into the space of six by two and a-half inches the author of this little work has compressed much valuable information. But a quarter of an inch thick, the book fits easily into the vest pocket, and it can be commended to electrical men in general, but to the public in particular. In the latter case it fills a distinct want. By the public we mean that class sufficiently interested financially, or, may be, commercially, in electrical affairs. The author has saved us the trouble of reviewing, as in a series of long sentences be sums up his opinion of the work. There is a handy thumb index, making reference easy and complete.

Dynamo Attendants and their Dynamos.

By F. Broadbent. S. Rentell & Co., Ltd., 36 Maiden Lane, Strand, W.C. Price 1s. 6d.

This title will be familiar to some of our readers as that of Mr. A. Gibbings' little book published ten years ago and widely circulated. The demand has evidently increased, as the edition before us presents the same subject, but re-written and modernised by a new author. The field of dynamo electric machinery has extended so considerably since the first edition above mentioned appeared, that a corresponding increase in the scope of the new work was to be looked for, and we can safely say that there has been no loss in spite of this. Dynamo attendants, whether they handle direct or alternate current plant, will find their needs equally well catered for, while the ever-increasing motor is not overlooked. The book is worth the investment of any dynamo attendant or electrician having charge of plant.

Entropy or Thermodynamics from an Engineer's Standpoint.

By James Swinburne. Archibald Constable & Co., Ltd., London. Price 4s. 6d. nett.

All engineers will remember the interest aroused by an unorthodox statement regarding entropy, made last year by Mr. Swinburne, in his presidential address to the Institution of Electrical Engineers, and the heated discussion which ensued in the technical press of the time. Shortly after the incident, Mr. Swinburne defined his views more explicitly in a series of articles which appeared in *Engineering*, and these articles he has now collected, and used to form the basis of the present work. Entropy, from whatever standpoint it is considered, is not an easy subject to master. Heat, pressure, volume, and even energy, seem more or less tangible quantities of which some sort of physical conception may be formed, but entropy strikes the engineer as something unreal, a kind of mysterious abstraction invented by the thermodynamicians and placed on the threshold of their science. Until recent years, he had no idea of its existence, for it never shewed on his indicator card, pressure gauge, or thermometer, and the engines seemed to work quite well without it. He regarded the steam engine as a pressure engine pure and simple, and the indicator diagram told him all he wished to know about its action. The fact that a steam engine was fundamentally a heat engine, which took in a certain amount of heat at a high temperature, and rejected a less amount at a lower temperature, converting the balance into work, was thrust upon his notice by the thermodynamicians, who further proved to him that, *cæteris paribus*, the efficiency of the engine depended upon the limits of temperature between which it operated.

In pursuing the thermodynamical investigation of the subject, a diagram was evolved analogous in some respects to the indicator diagram. The area represented work, though in heat units instead of footpounds, the co-ordinates, instead of denoting pressure and volume, being used to represent temperature, and the unfamiliar quantity "entropy." The heat diagram, or θ diagram, as it was often called, gave very valuable information about the amount of water present in the steam at various points of the cycle as well as other matters, and was soon recognised as essential for the study of heat engines. Exactly what was the meaning of "entropy" was not very clear to the engineer. The co-ordinate of heat with temperature, or the result when a quantity of heat was divided by the temperature at which it was transmitted to the working substance; or mathematically $\int\frac{dH}{\theta}$; were given as definitions, and whether understood or not, appeared consistent with the diagram. Mr. Swinburne's point of view is that the confusion which undoubtedly exists in the minds of many engineers, is due entirely to the slipshod habits of thought and loose expressions of physicists. They have discussed imaginary reversible cycles of operation, assuming that the engine and working substance were both perfect. Such a conception is undoubtedly valuable in its place, but unfortunately in nature, reversible cycles are as much out of the way as frictionless mechanisms. The existence of either would involve the possibility of perpetual motion, because the reversibility of any cycle, and the absence of friction both imply that no energy has been lost in either the cycle or the motion. In every physical change, however, there is always some waste or degradation of energy, and such waste can never be recovered. Mr. Swinburne, therefore, objects to the usual definitions of entropy, based on reversible cycles, and maintains that such definitions are inaccurate and misleading. He proposes to define increase of entropy as that quantity which, when multiplied by the lowest available temperature, gives the incurred waste. We have no intention of entering into the discussion at the present time, but recommend those interested in the question to read Mr. Swinburne's case for themselves. The book is not intended to teach the student how to construct entropy diagrams and no entropy tables are included. It is written with the hope of causing engineers to think and understand what the diagram really represents, and as it is non-mathematical, and lightened by touches of humour, it forms a very readable work on a difficult subject.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects will be arranged *under subject-matter* in this section. Suitable references will be made to the names and dates of the various papers, and the whole will form an index guide of considerable importance and value.

Power.

Articles.

Electrical Installation on Board Warships (serial). Leblond.	*L'Ind. Elec.* 25/4/04. 10/5/04.
Hydro-Electric Steel Works at Gysinge. Dary.	*L'Electn.* 14/5/04.
*Snoquahnie Falls and White River Power Developments.	*Elec. Wld. & Eng.* 7/5/04.
Electrical Regulator for Steam Turbines. Dary.	*L'Electn.* 7/5/04.
Electricity in Agriculture. E. Guarini.	*L'Electn.* 7/5/04, 14/5/04.
Central Electric Supply Co.'s Power Station (concld.)	*Elec. Rev.* 13/5/04.
*Hudson River Power in Albany, Troy and Schenectady	*Elec. Wld. & Eng.* 14/5/04.
Steam Engines *v.* Gas Engines. Capitaine.	*Zeit. Deuts. Ingen.* 14/5/04.
Gas as Fuel for Steam Boilers. C. W. Bildt.	*Tek. Tids.* 14/5/04.
The Electrical and Mechanical Equipment of a Modern European Theatre. J. Koster.	*Elec. Rev. N.Y.* 14/5/04.
Electricity in Crane Building (concld. 1/6/04). Hch. Rupprecht.	*Elektro. Rund.* 15/5/04.
Steam Turbines. Drin.	*La Rev. Elec.* 15/5/04.
New Station, Edison Electric Illuminating Co., Boston.	*Elec. Rev. N.Y.* 21/5/04.
Expansion of the Boston Edison System.	*Elec. Wld. & Eng.* 21/5/04.
*Aspects of New England Central Station Development.	*Elec. Wld. & Eng.* 21/5/04.
*Central Station System Edison Electric Co., Boston. J. S. Browning.	*Westn. Elec* 21/5/04.
Kubel Hydro-Electric Power House and Auxiliary Steam Plant. F. C. Perkins.	*Electy. N.Y.* 25/5/04.
Method for the Determination of the Output of a Waterfall. Loppé.	*L'Ind. Elec.* 25/5/04.
*A Large Modern Paris Generating Plant. C. L. Durand.	*Elec. Rev. N.Y.* 28/5/04.
*The Largest Electric Water Power Plant in New Hampshire. I. & II.	*Elec. Wld. & Eng.* 28/5/04 and 4/6/04.
Deriving Electricity Direct from Fuel. R. Pöthe.	*Elek. Ansr.* 29/5/04.
Notable Installation of the Renold Silent Chain.	*Machinery, N.Y. May* /04.
*Practical Applications of Electro-Magnets in the Modern Machine Shop. F. C. Perkins.	*Modern Machy, Chicago May* /04.
*Power Plant of the Yale and Towne Manufacturing Co.	*Power. May* /04.
Tests of the Engines of the Rochester Gas and Electric Co.	*Power. May* /04.
*Multiple Impact Steam Turbine. A. M. Levin.	*Power. May* /04.
The Conversion of Steam Cranes. H. E. M. Kensit.	*Elec. Times.* 2/6/04.
*The Cost of Electric Energy. G. L. Addenbrooke.	*Eng.* 3/6/04.
Electric Cranes. I. F. L. Berry.	*Mech. Wld.* 3/6/04.
Power Transmission in Works. W. E. Buck.	*Eng.* 3/6/04.
Internal Combustion Engines and the Deisel Principle. W. H. Booth.	*Elec. Rev.* 10/6/04.
New Sub-station at Helena, Montana.	*Amer. Elec. June* /04.
*The Generating Plant of the Kansas City Electric Light Co. E. A. Barth.	*Amer. Elec June* /04.
A Revolution in Prime Movers. Dr. L. Bell.	*Amer. Elec. June* /04.
Variable Speed Motors. (3). W. Baxter, Jr.	*Mach. N.Y. June* /04.

Papers before Societies.

Power Plant of Tall Office Buildings. J. H. Wells and R. P. Bolton.	*Amer. Assoc. Mech. Eng.* 2/5/04.
*Wave Form Variations of a Long Distance Line. G. A. Rowe.	*Amer. I.E.E.* 18/5/04.
A 100 mile Transmission Line. R. Howes.	*Nat. Elec. Lt. Assoc.* 24/5/04.
Electric Light and Power Plants and Ice Plants. C. L. Wakefield.	*Nat. Elec. Lt. Assoc.* 26/5/04.
Purchased Electric Power in Factories. W. H. Atkins.	*Nat. Elec. Lt. Assoc.* 26/5/04.
Types of Large Power Installations. F. A. C. Perrine.	*Nat. Elec. Lt. Assoc.* 26/5/04.
Recent Examples of Destructors for Town Refuse. G. Watson.	*Amer. Soc. Mech. Eng.* 1/6/04.
Refuse Destruction by Burning and the Utilization of Heat Generated. C. W. Russell.	*Amer. Soc. Mech. Eng.* 1/6/04.
Middlesbrough Dock Electric and Hydraulic Power Plant. V. L. Raven.	*Inst. Mech. Eng. (Chicago Meeting).* 1/6/04.

Different Applications of Steam Turbines. A. Rateau.	*Inst. Mech. Eng. (Chicago Meeting).* 1/6/04.

Traction and Transport.

Articles.

*Financial Results of Electric Railway Operation in Germany.	*St. Rwy. Jrnl.* 7/5/04.
Extension of the Schenectady Railway System. A. D. Adams.	*St. Rwy. Jrnl.* 7/5/04.
*Electric Railway Features at the World's Fair. W. E. Goldsborough.	*St. Rwy. Jrnl.* 7/5/04.
*Street Railway Accidents, their Causes, Prevention and Adjustments. H. W. Brooks, Junr.	*St. Rwy. Jrnl.* 14/5/04.
Lamme Single-phase Railway Motor.	*Westn. Elect.* 14/5/04.
*Performance of Automatic Signals under Unfavourable Conditions. Serial. H. S. Ballie.	*Rlrd. Gazette.* 20/5/04.
Giraud Apparatus for the Protection of Overhead Conductors. Montpellier.	*L'Electn.* 21/5/04.
*Electric Railway Car Houses Construction and Hazards.	*St. Rwy. Rev.* 21/5/04.
Practical Hints on Inter-Urban Electric Railway Operation. A. B. Herrick.	*St. Rwy. Jrnl.* 21/5/04.
*Train Despatching on the Rochester and Eastern Rapid Railway.	*St. Rwy. Rev.* 21/5/04.
Details of Floor or Bottom Framing of Modern Inter-Urban Cars. E. C. Boynton.	*St. Rwy. Rev.* 21/5/04.
*Train Testing. S. W. Ashe.	*St. Rwy. Rev.* 21/5/04.
Railway Politics and Electric Railway Operation in Italy. P. Lanino.	*Elek. Zeit.* 26/5/04.
Electrical Operation of Railways in America. H. T. Melby.	*Tek. Ugeb. (Christiania)* 26/5/04.
Overhead Tramway Construction.	*Elec. Rev.* 27/5/04.
Electric Traction on Swiss Railways. Giron.	*L'Electn.* 28/5/04.
Electric Operation of the Troïlsky Turning Bridge at St. Petersburg. Dieny.	*La Rev. Elec.* 30/5/04.
Veveysans Electric Railway, Switzerland.	*Lt. Rwy. & Tr. Jrnl. May* /04.
Leicester Corporation Electric Tramways.	*Tram. & Rwy. Wld. May* /04.
Underground Traction in Chicago.	*St Rwy. Rev. May* /04.
*Operating Data from the Concord and Manchester Branch of the Boston and Maine R.R.	*St. Rwy. Rev. May* /04.
Compressed Air in Electric Railway Work: The Air Brake.	*St. Rwy. Rev. May* /04.
Recent Experiments in Monophase Traction. E. Guarini.	*St. Rwy. Rev. May* /04.
*Hiring, Training, and Handling Employees in Electric Railway Work. II. C. H. Cox.	*St. Rwy. Rev. May* /04.
Electric Locomotives for N. Y. Central.	*Railrd. Gaz.* 3/6/04.
Chássis for Electric Automobiles. Bainville.	4/6/04.
Electric Transportation within the World's Fair Grounds. C. Marshall.	*Elec. Wld & Eng.* 4/6/04.

Papers.

*Alternate Current Signalling. J. B. Struble.	*Rwy. Sig. Assoc. N.Y.* 10/5/04.
*Effect of Self-Induction on Railway Motor Commutation. E. H. Anderson.	*Amer. Inst.E.E.* 17/5/04.
High Speed Electric Railway Experiments on the Marienfelde-Zossen Line. A. Siemens.	*Inst.E.E.* 26/5/04.

Lighting and Heating.

Articles.

*Precautions, Electrical and otherwise, to Prevent Fire in Chicago Theatres.	*Westn. Elec.* 30/4/04
Street Lighting by Nernst Lamps.	*Westn. Elec.* 7/5/04.
Incandescent Gas Light *v.* Arc Light (concld. 18/5/04). O. Arendt.	*Helios.* 11/5/04.
Street Lighting by Nernst Lamps. H. Joseph.	*Elec. Rev.* 13/5/04.
Foreign Electric Heaters and Cooking Apparatus. F. C. Perkins.	*Westn. Elect.* 14/5/04.
The Problems Improving Electric Lamps. H. N. Potter.	*Elec. Rev. N.Y.* 21/5/04.
The "Economique" Enclosed Arc Lamp. De Kermond.	*L'Electn.* 21/5/04.
Electrical Illumination of the Lousiana Purchase Exposition. C. Marshall.	*Elec. Wld. & Eng.* 21/5/04.
Measurement of the Insulation Resistance of an Electric Wiring System. E. F. Northrup.	*Elec. Wld. & Eng.* 21/5/04.
*A *Resumé* of Incandescent Electric Lamp Exhausting. L. E. Doane.	*Elec. Wld. & Eng* 21/5/04.
The Nernst Lamp.	*Elec. Wld. & Eng* 21/5/04.
*The Magnetite Arc Lamp. C. P. Steinmetz.	*Elec. Wld. & Eng* 21/5/04.
The Electric Lighting of Weaving Sheds and Spinning Mills.	*Pract. Eng.* 27/5/04
*Rise of Electric Lighting in New England. A. D. Adams.	*Elec. Wld. & Eng.* 28/5/04.
The Continuous Protection of Conductors.	*Elec. Rev.* 10/6/04.
*Small Candle Power Enclosed Arc Lamps for City Street Lighting. J. H. Hallberg.	*Amer. Elec. June* /04.
*The Wiring of Exposed Steel Frame Buildings. A. B. Weeks.	*Amer. Elec. June* /04.

Papers.

A Three-Wire, 500 volt Lighting System. W. S. Barnes.	*Nat. Elect. Lt. Assoc.* 24/5/04.
Luminous or Flaming Arc. W. E. Holmes.	*Nat. Elec. Lt. Assoc.* 24/5/04
The Organisation and Equipment of an Arc Lamp Department. S. G. Rhodes.	*Nat. Elec. Lt. Assoc.* 24/5/04.
Electric Heating. G. T. Ayer.	*Nat. Elec. Lt. Assoc.* 24/5/04.
District Heating. E. F. McCabe.	*Nat. Elec. Lt. Assoc* 26/5/04.
Signs and Decorative Lighting. A. Williams.	*Nat. Elec. Lt. Assoc.* 26/5/04.

Telegraphy and Telephony.

Articles.

Some Points on Electricity. The Future Quadruplex. W. H. Jones.	*Teleg. Age.* 1/5/04.
*The Telegraph in England (contd.) W. P. Phillips.	*Teleg. Age.* 1/5/04
Condenser Making. F. A. Wegnes.	*Amer. Telep. Jrnl.* 7/5/04.
Grave Charges against Cumberland Bell. W. L. Arnold.	*Amer. Telep. Jrnl.* 7/5/04.
The Voltmeter as used for Testing. F. C. Greenwald.	*Amer. Telep. Jrnl.* 7/5/04.

Automatic Fuse Alarm. G. S. Bundesman.	*Amer. Telep. Jrnl.* 7/5/04.
*Progress of Long Distance Telephony in 25 years.	*Amer. Telep. Jrnl.* 7/5/04.
*A Simple Telephone Accounting System. E. D. Schade.	*Amer. Telep. Jrnl.* 7/5/04.
Wireless Telephony with Selenium Cells (concld.). Gradenwitz.	*La Rev. Tec.* 10/5/04.
Wireless Telegraphy (contd.). R. G. Blaine.	*Elec. Eng.* 13/5/04.
*The Efficiency of Telephone Power Plant. B. D. Willis.	*Amer. Telep. Jrnl.* 14/5/04.
Rifle Range Telephone. H. G Wiley.	*Amer. Telep. Jrnl.* 14/5/04.
Apparatus for the Telegraphic Transmission of Manuscripts and Drawings. Gradenwitz.	*L'Electn.* 14/5/04.
"Step" Alarms. J. Baumann.	*Zeit. für Elek.* 15/5/04.
*The Cable Steamer Pacific.	*Elect.* 20/5/04.
*Use of the Peg Count in Central Office Operation. I. A. D. O'Brien.	*Amer. Telep. Jrnl.* 21/5/04.
Circuits for Toll Trunks. F. C. Greenwald.	*Amer. Telep. Jrnl.* 21/5/04.
*Protection of Telephone and Telegraph Lines in Proximity to H.T. Lines.	*Elec. Wld. & Eng.* 21/5/04.
A Dry Cell Common Battery System. E. A. Tyler.	*Amer. Telep. Jrnl.* 21/5/04.
*A Self-Cohering Receiver. E. Van Winkle.	*Elec. Wld. & Eng.* 21/5/04.
*Telephone Engineering. V. J. C. Kelsey.	*Elec. Rev. N.Y.* 21/5/04.
Telephone Tariffs.	*Jrnl. Teleg. de Berne.* 25/5/04.
Wireless Telegraphy (contd.). R. G. Blaine.	*Elec. Eng.* 27/5/04.
*New Signalling System, Consolidated Exchange, N.Y.	*Elec. Rev. N.Y.* 28/5/04.
Independent Telephone System of Kansas City. F. A. Parker.	*Amer. Telep. Jrnl.* 28/5/04.
Improvement in Magneto Switchboard Signalling. G. W. Lattig and C. L. Goodrum.	*Amer. Telep. Jrnl.* 28/5/04.
New Submarine Telephone Cables. Devaux Charbonnel.	*L'Electn.* 28/5/04.
*Automatic Exchange of the North Eastern Telephone Co.	*Amer. Elec. May* /04.
*Telephone Engineering, Protective Devices. F. G. Dommerque.	*Amer. Elec. May* /04.
The Leich Four-Party Selective Ringing System. A. D. O'Brien.	*Amer. Elec. May* /04.
Wireless Theories. Ferrié.	*L'Eclair Elec.* 4/6/04.
Telephone Statistics of U.S.A.	*Elec. Wld. & Eng.* 4/6/04.
*On a New Standard Wave Length. J. E. Ives.	*Elec. Wld. & Eng.* 4/6/04.
Problem of Private Telephone Branch Exchange. J. Baumann.	*Elek. Anzr.* 9/6/04.
Observations on Schloemilch Detector. M. Reich.	*Physik Zeit.* 15/6/04.
*Some Efficient Means of Managing Telephone Inspection Departments. C. H. Coar.	*Amer. Elec. June* /04.

Papers.

*Selective Signalling by Electrical Resonance. Dr. M. I. Pupin.	*N.Y. Elec. Soc.* 25/5/04.

Electro-Chemistry.

Articles.

Thermo-electric Experiments. Dr. C. Déguisne.	*Elek. Zeit.* 26/5/04.
A Way to Utilise Old Dry Batteries G. T. Havehett.	*Amer. Elec. May* /04.
*Electro-Chemistry at Wisconsin University. C. F. Burgess.	*Electro-Ind. May* /04.
On the Dissociation of Cupric Sulphide and the Decomposition of Copper Anodes. Tommasi.	*L'Electn.* 4/6/04.

Papers.

On the Electrolytic Dissolution of Platinum. Brochet and Petit.	*C. Rendus de l'Acad. des Scs. Paris.* 2/5/04.
Remarks on the Use of Alternate Current in Chemistry. Berthelot.	*Acad. des Scs. Paris.* 9/5/04.
On the Electrolysis of Calcium Chloride. Moissan.	*Acad. des Scs. Paris.* 16/5/04.

Electro-Physics.

Articles.

On the Realisation of a High Pressure Electrostatic Rotating Field. Guge and Benso.	*L'Eclair Elec.* 7/5/04.
The Thermic Variation in the Resistivity of Mercury. Guillaume.	*L'Ind. Elec.* 10/5/04.
Utilisation of Wattmeter as Phasemeter. F. H.	*L'Ind. Elec.* 10/5/04.
On the Production of Sinusoidal Currents. F. H.	*L'Ind. Elec.* 10/5/04.
The Conductometer. R. Appleyard. (contd. 20/5/04.)	*Elec. Rev.* 13/5/04.
Device for Measuring Induction Constants and Energy Loss in Alternate Current Machinery. Dr. F. Dolezalek.	*Elektro. Rund.* 15/5/04.
Origin of Radio-active Energy. Breydel.	*L'Electn.* 21/5/04.
New Hot-wire Voltmeter. Davy.	*L'Ind. Elec.* 25/5/04.
*A New Portable Capillary Electrometer. L. Ramakers.	*Electy. N.Y.* 25/5/04.
To Balance the Plates of a Winshurst Machine. J. M. Blake.	*Elec. Rev. N.Y.* 28/5/04.
Magnetic Dispersion in Asynchronous Motors. Guilbert.	28/5/04.
*An Expression for the Torque of a Polyphase Wattmeter. F. R Stowe.	*Elec. Wld. & Eng.* 28/5/04.
*Alternating Current Wave Power Analysis. S. M. Kintner.	*Elec. Wld. & Eng.* 28/5/04.
Anemometric Dynamometer of Col. Ch. Renard. F. Ross.	*Zeit. für Elek.* 29/5/04.
Chemical Action of Cathode Rays. E. Bose.	*Physik Zeit.* 15/6/04.
Radio-activity of Soils, etc. J. Elster and U. Feild.	*Physik Zeit.* 15/6/04.
Influence of Temperature Variations on Radio-activity Substitution. H. Meyer.	*Physik Zeit.* 15/6/04.
*Curve Drawing on Graphic Recording Instruments. H. W. Young.	*Amer. Elec. June* /04.

Papers.

On the Radio-activity of Gases Evolved from Thermal Springs. Curie et Laborde.	*Acad. des Scs. Paris.* 9/5/04.
Electric Osmosis in Methylic Alcohol. Baudouin.	*Acad. des Scs. Paris.* 9/5/04.
*The Radiation and Emanation of Radium. E. Rutherford.	*Royal Inst.* 20/5/04.
The Law of Action between Magnets and its Bearing on the Determination of Horizontal Component of the Earth's Magnetic Field with Unifilar Magneto meters. C. Chree.	*Phys. Soc.* 27/5/04.
On Coherence and Decoherence.	*Phys. Soc.* 27/5/04.

On the Simultaneous Emission of N and N_1 Rays. Becquerel.	*Acad. des Scs. Paris.* 30/5/04.
Electric Oscillations and Corresponding Overpressures. Picou.	*Bull. de la Sté. Int. des Electns. May* /04.
Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena. C. A. Wright.	*Röntgen Soc.* 2/6/04.
Development of the Theory of Electrolytic Dissociation. Prof. S. Arrhenius.	*Royal Inst.* 3/6/04.
A Model, Illustrating the Propagation of a Periodic Electric Current in a Telephone Cable and the Simple Theory of its Operation. Prof. J. A. Fleming.	*Phys. Soc.* 10/6/04.

Electro-Metallurgy.

Articles.

Electro-metallurgy. François and Tissier.	*La Rev. Tech.* 10/5/04.
Edison Accumulator: Metallurgical Applications of Vanadium and Aluminium. Cyr Wattiez.	*L'Ind. Tex.* 15/5/04.
Electric Process for the Winning of Nickel and Garnerite.	*Le Electrl.* 15/5/04.
The Treatment of Copper Ore in the Electrical Furnace.	*L'Ind. Elect. May* /04
Haas and Oettel Electrolysers for Bleaching.	*L'Ind. Elect. May* /04

Papers.

The Electric Furnace: Its Origin, Transformations, and Applications. A. Minet.	*Faraday Soc.* 9/6/04.

Students.

Articles.

*Alternating Current Working, III. W. B. Gump. (IV. 7/5/04; V. 21/5/04.)	*Westn. Elec.* 30/4/04.
Training of Installation Personnel with Respect to Safety of Electric Plants. A. Böttcher.	*Elek. Anzr.* 26/5/04.

Papers.

The Tuition (?) of Electrical Engineering. J. Pigg.	*Newcastle Inst.E.B.* 9/5/04.
Notes on Steam Turbine Testing. C. F. Seeley.	*Inst. E.E. (Stdnts.)* 18/5/04.

Manufacturers.

Articles.

*Winding Railway Motor Armature. H. D. Robertson.	*Elec. Club Jrnl.* 2/5/04.
Electrical and Mechanical Engineering in the Exposition Plant. J. R. Cravath.	*Elec. Wld. & Eng.* 7/5/04.
The World's Fair Machinery Display. G. L. Carden.	*Elec. Wld. & Eng.* 7/5/04.
*A Convenient Economical Method for Determining Mechanical Torque. A. S. McAllister.	*Elec. Wld. & Eng.* 7/5/04.
New Starting and Change Gear Device for Electro-Motors. Reyval.	*L'Eclair Elec.* 7/5/04.
Testing Alternate Current Transformers. R. Krause.	*Helios.* 11/5/04.
*Steam Turbine Discs. M. F. Fitzgerald.	*Engr.* 13/5/04.
*Electrical Exhibits at the Opening of St. Louis Exhibition.	*Elec. Wld. & Eng.* 14/5/04.
Exhibits in the Palace of Electricity on the Opening Day. W. E. Goldsborough.	*Westn. Elect.* 14/5/04.
Magnetic Dispersion in Asynchronous Motors. Guilbert.	*L'Eclair Elec.* 14/5/04.
The Zoelly Steam Turbine. Weishäupl.	*Zeit. Deuts. Ingen.* 14/5/04.
Electrolytic Bleaching. Tailfer.	*L'Ind. Tex.* 15/5/04.
Analytical and Graphical Method for Calculating Closed Line Systems (contd. 22/5/04). P. M. Verhoeckx.	*Zeit. für Elek.* 15/5/04.
Circuit Connections for Compound Machinery. W. Küppers.	*Helios.* 18/5/04.
Potential Fall in Alternate Current Generators. Dr. H. Behn-Eschenburg.	*Elek. Zeit.* 19/5/04.
Test on an Alternate Current Dynamo of the Schüttorf Machine Shops. W. Winckelmann.	*Elek. Zeit.* 19/5/04.
Storage Battery Plate Construction, with Special Reference to High Discharge Characteristics.	*Elec. Wld. & Eng.* 21/5/04.
Notes on Asynchronous Motor Diagrams. Bléquet.	*L'Eclair Elec.* 21/5/04.
Electric Steel Tempering Process. G. Dary.	*L'Electn.* 21/5/04.
The Construction of Alternators at Preston. E. Guarini.	*L'Eclair Elec.* 21/5/04.
Building of Electrical Machinery. J. Löwy.	*Zeit. für Elek.* 22/5/04.
*The Use of Wrought-iron in Place of Cast-iron in Modern Dynamo Designs. W. Wolff.	*Helios.* 25/5/04.
Induction Coil Design (contd.). M. A. Codd.	*Elec. Rev.* 27/5/04.
Types of Direct Current L.T. Switchgears. IV. (Concld. 3/6/04). W. E. Warrilow.	*Elec. Eng.* 27/5/04.
The Repulsion Motor. Serial. F. W. Carter.	*Elec. Rev.* 27/5/04 and 3/6/04.
On Monophase Commutator Motors. (Serial.) Lehmann.	*L'Eclair Elec.* 28/5/04 and 4/6/04.
Manufacture of Air Insulated Telephone Cables, including Several Strings. J. Schmidt.	*Zeit. für Elek.* 29/5/04.
Storage Battery Exhibits at St. Louis. C. Marshall.	*Amer. Elec. May* /04.
*Construction of a Three-Phase Synchronizer. P. C. Percy.	*Amer. Elec. May* /04.
The Steam Turbine Situation. A. M. Earl.	*Amer. Elec. May* /04.
Variable Speed Motors, II. W. Baxter, Junr.	*Machinery, N.Y. May* /04.
Tests on a 4,000 h.p. Steam Turbine.	*Machinery, N.Y. May* /04.
Single-phase Alternate Current Motors for High Torques. F. Collischonn.	*Elektro. Rund.* 1/6/04.
Use of Electricity in Crane Building, etc. (concld.).	*Elektro Rund.* 1/6/04.
The Winning of Ores and their Magnetic Preparation. Jouve.	*L'Electn.* 4/6/04.
Efficiency Curves of Rotary Converters. A. S. McAllister.	*Elec. Wld. & Eng.* 4/6/04.
*A New Slip Meter. F. Welz.	*Elec. Wld. & Eng.* 4/6/04.
A New Fuse for High Tension Circuits. F. Collischonn.	*Elec. Zeit.* 9/6/04.
Why Use Carbon Brushes on a Modern Dynamo? J. W. Burleigh.	*Elec. Rev.* 10/6/04.
*The Louisiana Purchase Exposition.	*Amer. Elec. June* /04.
Plug and Socket Connections for Electrical Testing Rooms. T. C. Emerson.	*Amer. Elec. June* /04.
Testing Recording Wattmeters. G. T. Hanchett.	*Amer. Elec. June* /04.
Pelton Water Wheel Co.'s Test Room. G. J. Henry, Jr.	*Amer. Elec. June* /04

Papers.

Commercial Gas Engine Testing and Proposed Standard of Comparison.	*Amer. Assoc. Mech.* 2/5/04.
*Predetermination of Sparking in Direct Current Machines. W. L. Waters.	*Amer. Inst. E.E.* 17/5/04.
*Data and Tests on a 10,000 Cycle per Second Alternator. B. G. Lamme.	*Amer. I.E.E.* 18/5/04.
The Single-Phase Induction Motor. W. S. Franklin.	*Amer. I.E.E.* 18/5/04.
Standard Instruments for Operating Companies. H. P. Davis.	*Nat. Elec. Lt. Assoc.* 26/5/04.
The Closing of an Alternator on a Distributing Circuit. Brylinski.	*Bull. de la Sté. Int. des Electns. May* /04.
Theoretical and Practical Considerations in Steam Turbine Works. F. Hodgkinson.	*Amer. Soc. Mech. Eng.* 1/6/04.
De Laval Steam Turbine. E. S. Lea and E. Meden.	*Amer. Soc. Mech. Eng.* 1/6/04.
Curtes' Steam Turbine. W. L. R. Emmett.	*Amer. Soc. Mech. Eng.* 1/6/04.
Different Application of Steam Turbines. A. Rateau.	*Amer. Assoc. Mech. Eng.* 1/6/04.
The Potential Efficiency of Prime Movers. C. V. Kerr.	*Amer. Assoc. Mech. Eng.* 1/6/04.
Economy Test of 5,500 h.p. Generator and Engine. J. D. Andrew and W. F. Wells.	*Nat. Elec. Lt. Assoc.* 25/6/04.

Central Station Practice.

Articles.

The Thermal Effect and Practical Utility of Super-Heated Steam. R. H. Smith.	*Elec. Rev.* 13/5/04.
Determining Insulation Resistance of the Conductors Constituting a Direct Current Multiple Conductor Plant During Operation. Dr. J. Sahulka.	*Elek. Zeit.* 26/5/04.
Steam Curves. W. H. Booth.	*Elec. Rev.* 27/5/04.
*Lubricating Oils and their Properties: To Test them and Detect Adulterations. W. Davis.	*Power. May* /04.
Furnace Fittings for Steam Boilers. R. T. Strohm.	*Amer. Elec. June* /04.
*Construction of a Two-Phase Synchronizer. P. C. Percy.	*Amer. Elec. June* /04.
*Engine Room Management.	*Amer. Elec. June* /04.

Papers.

*On the Calculation of Line Batteries. W. E. Winship.	*Amer. Inst. E.E.* 17/5/04.
Notes on Flywheels. H. H. Barnes, jun.	*Amer. Inst. E.E.* 18/5/04.
Lost and Unaccounted for Current. C. W. Humphrey.	*Nat. Elec. Lt. Assoc.* 24/5/04.
Grounding the Neutral of High Voltage Generators. G. W. Eastman.	*Nat. Elec. Lt. Asso.* 24/5/04.
Remote Control of Electrical Apparatus. W. H. Cole.	*Nat. Elec. Lt. Assoc.* 24/5/04.
Economy in Minor Station Supplies.	*Nat. Elec. Lt. Assoc.* 25/5/04.
Single-phase Motors for Electric Lighting Stations. W. A. Layman.	*Nat. Elec. Lt. Assoc.* 26/5/04.
Analysis of Flue Gases. H. L. Doherty.	*Nat. Elec. Lt. Assoc.* 26/5/04.
The Burning of Town Refuse. G. Watson.	*Inst. Mech. Eng. (Chicago Meeting).* 1/6/04.
Refuse Destruction by Burning and the Utilization of Heat Generated. C. W. Russell.	*Inst. Mech. Eng. (Chicago Meeting).* 1/6/04.
The Mechanical Stoker and Human Operator. E. Yawger.	*Nat. Elec. Lt. Assoc.* 25/6/04.
Investigation of Steam Turbines. W. C. L. Eglin.	*Nat. Elec. Lt. Assoc.* 25/6/04.
Practical Notes an Steam Turbines. F. Hodgkinson.	*Nat. Elec. Lt. Assoc.* 25/6/04.
The Internal Combustion Engine in Central Station Service. E. E. Arnold.	*Nat. Elec. Lt. Assoc.* 25/6/04.

Trade and Commerce.

Articles.

Contribution to Tariff Question of Electricity Works. Schönbon.	*Elek. Zeit.* 12/5/04.

* * *

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

* * *

New Catalogues.

Under this heading, a list alphabetically arranged UNDER SUBJECT-MATTER, *with names and addresses of manufacturers, is given of all the more important new catalogues of electrical machinery, appliances, and specialities issued during the month. A complete index is kept at these offices of all catalogues mentioned here, and reference can be made to same at any time by prospective customers or bona-fide business enquirers.*

* * *

Power.

Refuse Destructors.

THE "HORSFALL" DESTRUCTOR COMPANY, LTD., Leeds, have sent us three interesting pamphlets dealing with their "Horsfall" destructor. The first of these is a report by Mr. J. W. Brown, M.I.C.E. (late borough engineer of West Hartlepool), on the working of the "Horsfall" destructor at West Hartlepool. The entire report makes very interesting reading, and brings out the chief features of the plant. The second is list No. 1, containing particulars of "Horsfall" destructor installations in all parts of the world. Opposite a photograph of each plant details of erection, number of cells, refuse destroyed in 24 hours, &c., are given. The brochure closes with particulars of clinker railway, crushing rolls, and mortar mills. The third pamphlet contains authentic reports from towns in which "Horsfall" destructors are at work.

Electric Lifts.

J. E. SPAGNOLETTI & Co., Goldhawk Works, Shepherd s Bush, W., have sent us an elaborate catalogue describing "Stigler" lifts. The pamphlet is made up of loose pages, corded in a neat cover, each page containing a photograph of the various types of lifts constructed. We shall make reference in our next issue to the electrical features of these lifts, giving therewith some illustrations of the same.

Motors for Machine Driving.

MESSRS. JOHNSON & PHILLIPS, LTD., of Old Charlton, Kent, have sent us a handbook entitled "The Application of Electric Motors to Machine Driving." This is a very interesting booklet, and should be in the hands of anyone contemplating the introduction of electricity for motive power purposes. It is carefully sectionised into chapters, each of which deals concisely with some special aspect of the question. The book is by Andrew Stewart, A.M.I.E.E., and we understand a copy will be forwarded to any interested in electricity as a motive power, especially the iron and metal textile and printing trades.

Steam Engines.

MATHER & PLATT, LTD., Salford Iron Works, Manchester, have issued the second edition of their engine catalogue. This is reproduced in first-class style, and contains particulars of the largest and smallest sizes of engines constructed by the firm. The large engines are of the double acting open vertical marine type, arranged for condensing or non-condensing, simple, or compound, as required. The catalogue contains details of horizontal engines and condensing plant. Some useful hints to enquirers, which might be followed with advantage to all concerned, are given on the last page.

Turbine Pumps.

MATHER & PLATT, LTD., Salford Iron Works, Manchester. This is the second edition of the firm's catalogue dealing with high lift turbine pumps. Valuable curves and tables relative to the performance of these pumps are given, and the catalogue is illustrated with a number of good photographs In the power section of this issue, page 594, we give some details of installations fitted with these pumps.

Electric Drills.

E. H. CADIOT ET CIE., 12 Rue St. Georges, Paris. An eight-page pamphlet gives particulars of the portable electric drills specialised by this firm. The devices are exceedingly neat, and illustrate in a striking manner what can be done with portable electric tools. In our next issue we shall give some illustrations of these devices.

Forthcoming Events

A complete list of the meetings of various Electrical Societies and Institutions (together with papers to be read), notifications of any gatherings, expeditions, or conferences in connection with electrical subjects, is listed under order of date in this section.

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

Now open. Remains open till *December 1st, 1904.*

Colliery Exhibition, Royal Agricultural Hall, London.

June 25th to July 2nd, 1904.

Third International Congress of Mathematicians, Heidelberg.

August 8th to 13th, 1904.

Exposition Internationale au Grand Palais, Paris.

August to November, 1904.

Industrial Exhibition, Cape Town.

November, 1904, to January, 1905.

Institution of Electrical Engineers' Visit to America.

THE date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition (see note below). The party will leave England on or about August 26th or 27th, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England. Unless 40 members are assured for the party, the arrangements will not be proceeded with.

The Tramways and Light Railways Exhibition, 1905, Agricultural Hall.

July 3, 1905.

Papers before Societies.

St. Louis International Association of Municipal Electricians.

September 13th and 14th, 1904.

"Street Lighting: Principles Involved and Systems Used. A. S. Hatch.

"The Limitations of the Telephone for Fire Alarm Purposes." A. Bosch.

"The Inspection of Theatres from an Electrical Standpoint." W. H. Thompson.

"Methods of Testing." W. M. Petty.

Meetings, Conventions, etc.

Institution of Electrical Engineers.

Annual Conversazione, Natural History Museum Road, Cromwell Road, S.W. *June 28th, 1904.*

Incorporated Municipal Electrical Association.

Annual Meetings (Derby, Nottingham, Sheffield), *June 29th to July 2nd, 1904.*

Programme, unless subsequently modified:

Derby, Wednesday, June 29th.

Morning.—Presidential Address. Paper: "The Commercial Practicability of Electric Traction by Surface Contacts"; C. E. Shawfield.

Afternoon.—Excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation.

Nottingham, Thursday, June 30th.

Morning.—Papers: "Polyphase Sub-stations, their Equipment and Working"; S. L. Pearce. "Some Notes on the Bristol Electricity Works Fire"; H. Faraday Proctor. "Boiler House Economies"; R. S Downe.

Afternoon.—Visit to electricity works and other works.

Evening.—Members' annual dinner.

Sheffield, Friday, July 1st.

Morning.—Papers: "The Financial Position of Municipal Electrical Undertakings"; Councillor Blakeway. "The Organisation and Management of the Meter Department"; A. J. Cridge.

Afternoon.—Visit to electricity works and other works.

Derby, Saturday, July 2nd.

Morning.—Annual general business meeting (members only).

American Street Railway Association.

23rd Annual Convention. St. Louis Exposition. *October 12th and 13th, 1904.*

American Electro-therapeutic Association.

Annual Convention, St. Louis. *September 13th to 16th, 1904.*

International Electrical Congress, St. Louis Exposition.

Conventions will be held by the following Societies: the American Institute of Electrical Engineers, the American Physical Society, the American Electrochemical Society, the American Electro-therapeutic Association, the International Association of Municipal Electricians, the British Institution of Electrical Engineers. Delegates from the Société Internationale des Electriciens, the National Electric Light Association and the Association of Edison Illuminating Companies.

The following papers have been promised for section A, the section on theory, of which Professor E L. Nichols is chairman and Professor H. T. Barnes is secretary:

Foreign—"Metallic Conduction," Professor Dr. Paul Drude; "Electrical Standards," Professor Dr. W. Jaeger; "Ions," Sir Oliver Lodge; "Magneto-Striction," Professor H. Nagaoka; "The Theory of Ionisaton by Collision," Professor J. S. Townsend; Secondary Standards of Lights," M. J. Violle; "Condensation Neuclei," Mr. C. T. R. Wilson; "Magneto-Optics," Professor P. Zeemann. American—"The Mechanical Equivalent of Heat as Measured by Electrical Means," Professor H. T. Barnes; "Atmospheric Neuclei," Dr. Carl Barus; "The State of Our Knowledge Regarding the Earth's Magnetism," Dr. Louis A. Bauer; "Magneto-Optics," Professor D. B. Brace; "The Absolute Value of the Electromotive Force of the Clark and Weston Cells," Professor H. S. Carhart and G. W. Patterson, Jr.; "The Electric Arc," Professor C. D. Child; "Coherer Action," Dr. K. E. Guthe; "Electrical Discharges in Gases," Professor E. P. Lewis; "Electro-Striction," Professor L. T. More; "The Unobtained Wave-Lengths between the Longest Thermal and the Shortest Electric Waves yet Measured," Professor E. Fox Nichols; "Standards of Light," Professor E. L. Nichols; "Magnetic Effect of Moving Charges," Harold Pender; "Electrical Theory," Dr. M. I. Pupin; "Alternating-Current Measurements," Dr. Edward B. Rosa; "Radioactive Change," Professor E. Rutherford; "Radioactivity of the Atmosphere," Professor J. C. McLennan; "Electrical Discharge in Gases," Professor J. Trowbridge; "Electrical Theory," Professor A. G. Webster.

UNIV. OF MICH.
JAN 20 1910

UNIVERSITY OF MICHIGAN
3 9015 07499 1632

157-

Google